NCT®

Machine Tool Controls

Installation Manual

from Software Version x.057 (M) (L)

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February 25, 2003

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1 COMPONENTS AND MOUNTING DIMENSIONS OF CONTROL

The control is built up of two main units :

operator's panel and

logic unit.

The operator's panel containing the monitor, the data input keyboard and optionally machine control panel 2 must be built in the machine ergonomically to the optimal place.

The logic unit must be placed suitably in the magnetics cabinet of the machine.

The obligation concerning the distance of the two units is that the length of signal cables between them (video and CAN bus cables) cannot be over **30 m**.

1.1 Components and Mounting Dimensions of Operator's Panel

the operator's panel is made up of three main units:

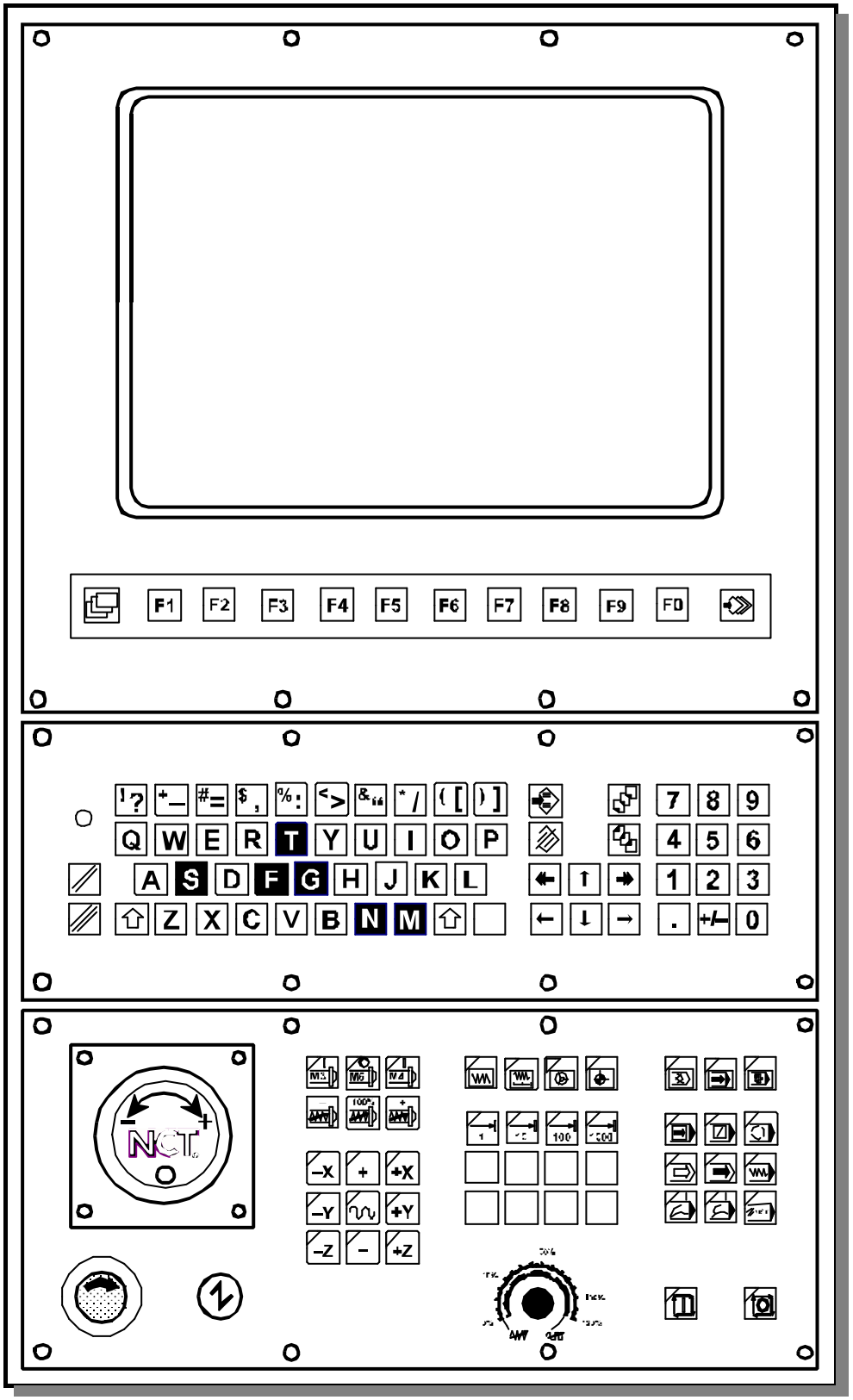
monitor, either monochrome or color,

data input keyboard,

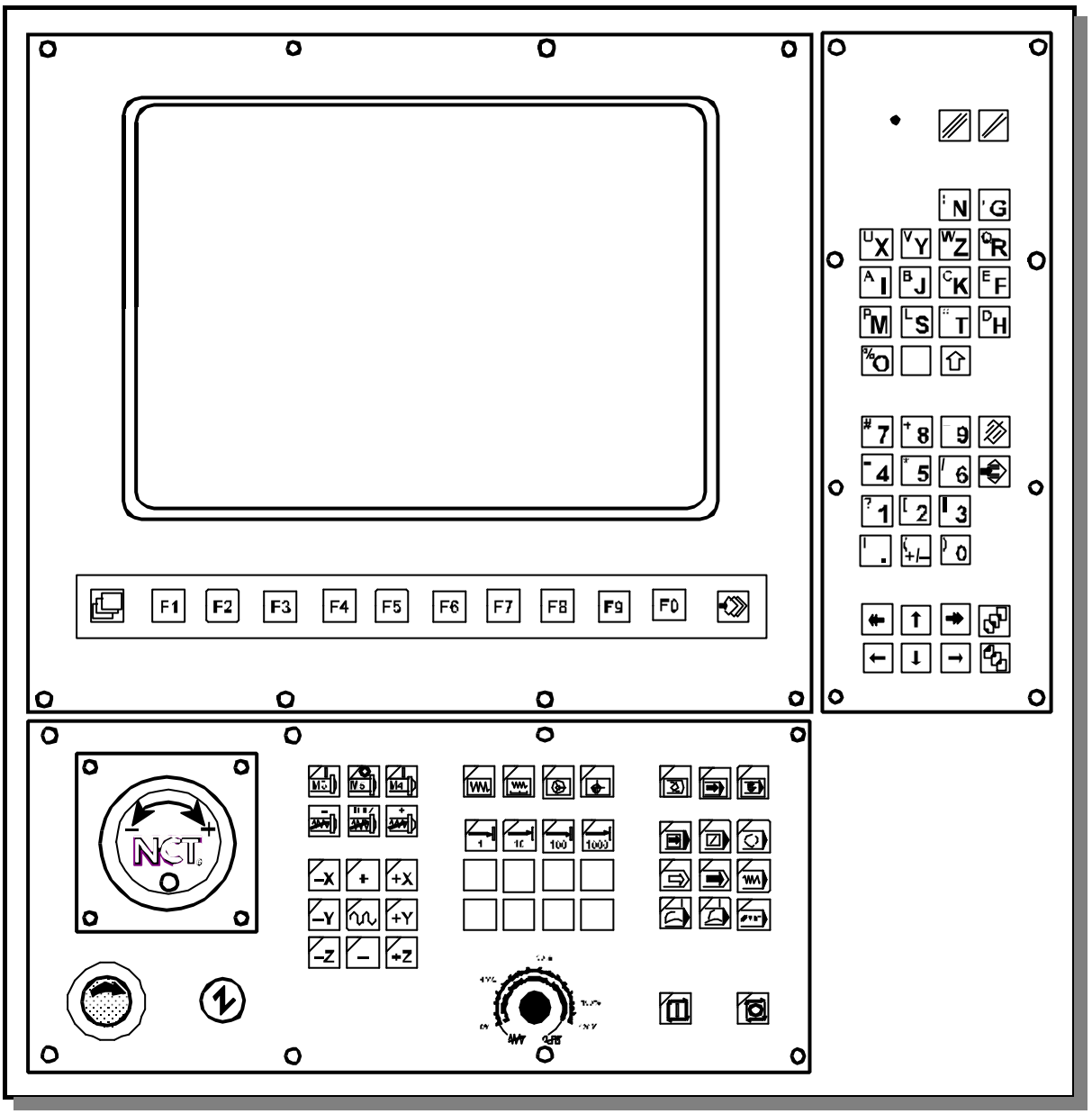
and **machine control panel**.

Standard accessories of control are the monitor and the data input keyboard.

1.1.1 Operator's Panel with Color Monitor



Assembly drawing of **color monitor** unit, of **63-button** alphanumeric **keyboard** mounted under and of optional **machine control panel 2**



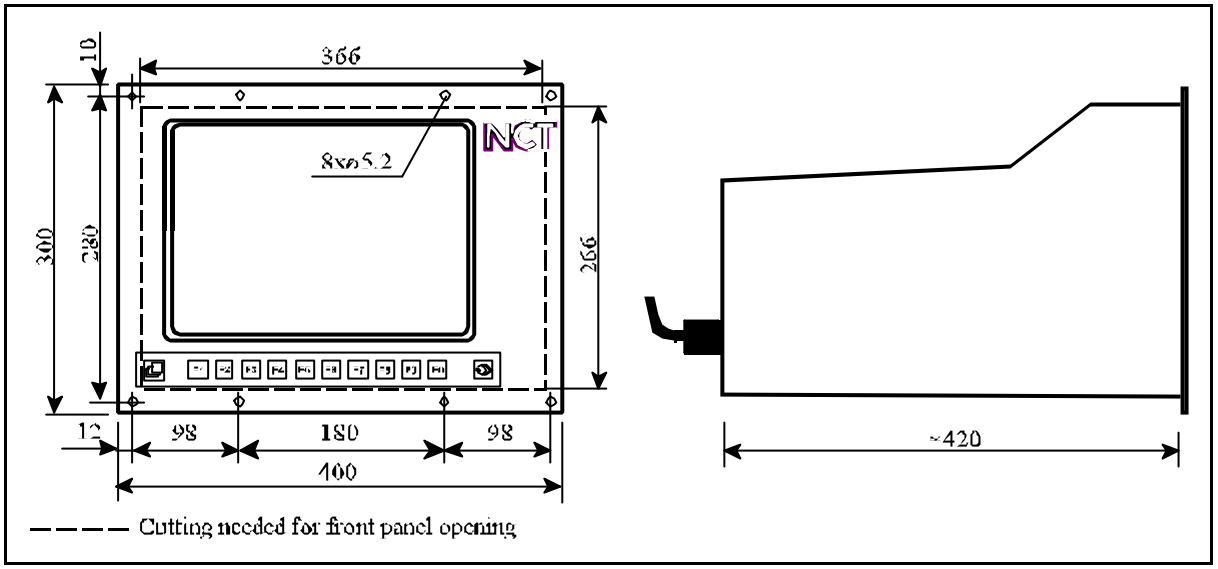
Assembly drawing of **color monitor** unit, of **41-button** alphanumeric **keyboard** mounted beside and of optional **machine control panel 2**

Two kinds of color monitors can be applied:

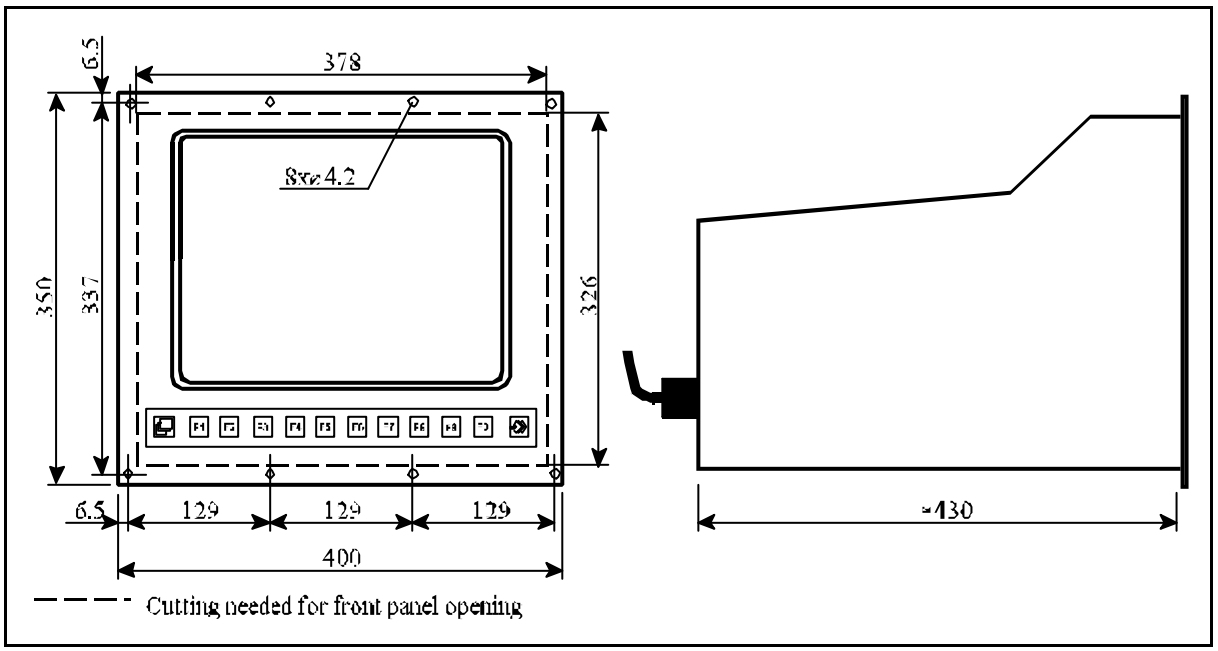
– 14" or

– 15".

The width of the two monitor units is identical the other mounting dimensions differ. In case of a 41-button- monitor the height of the alphanumeric keyboard built in corresponds to that of the 15" monitor.

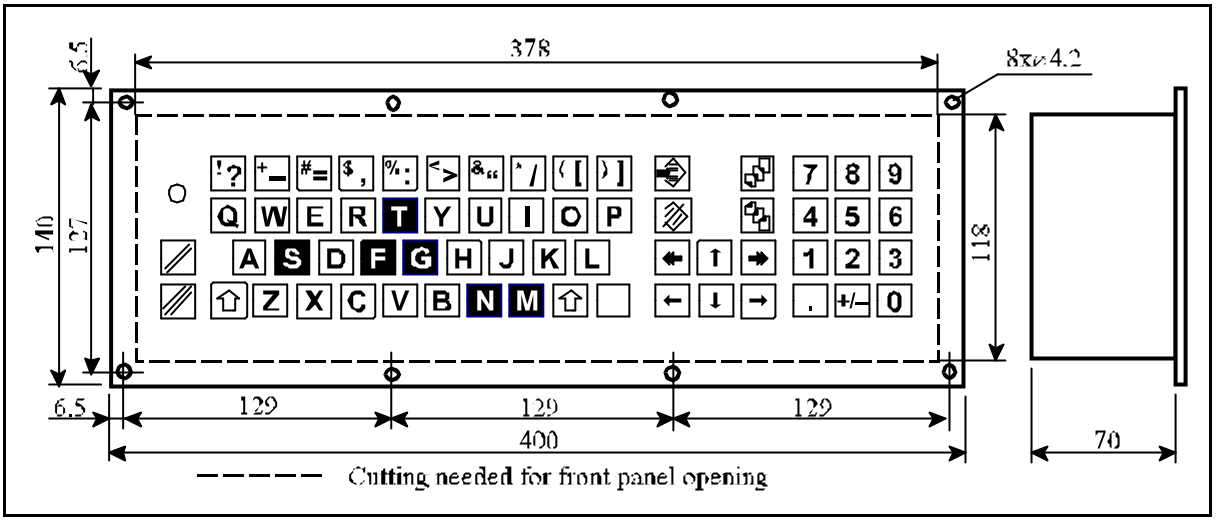


Mounting dimensions of **14"** color **monitor** unit

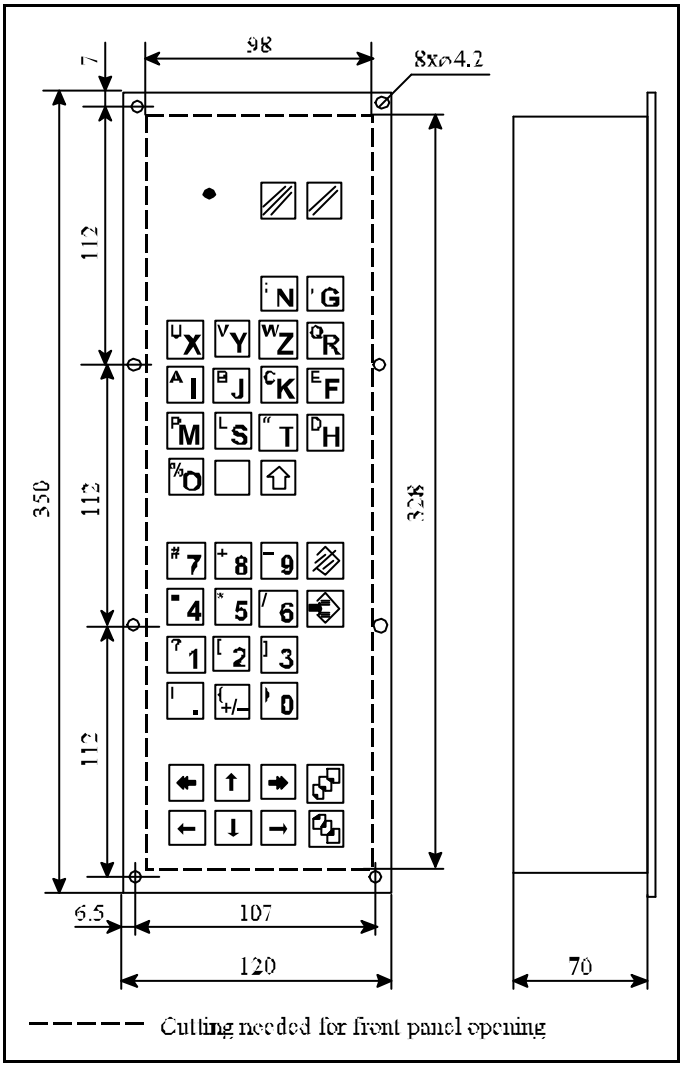


Mounting dimensions of **15"** color **monitor** unit

☞ ***Warning! The monitor unit must be built as far from transformers and high-voltage cables as possible in order to assure the finest picture quality.***

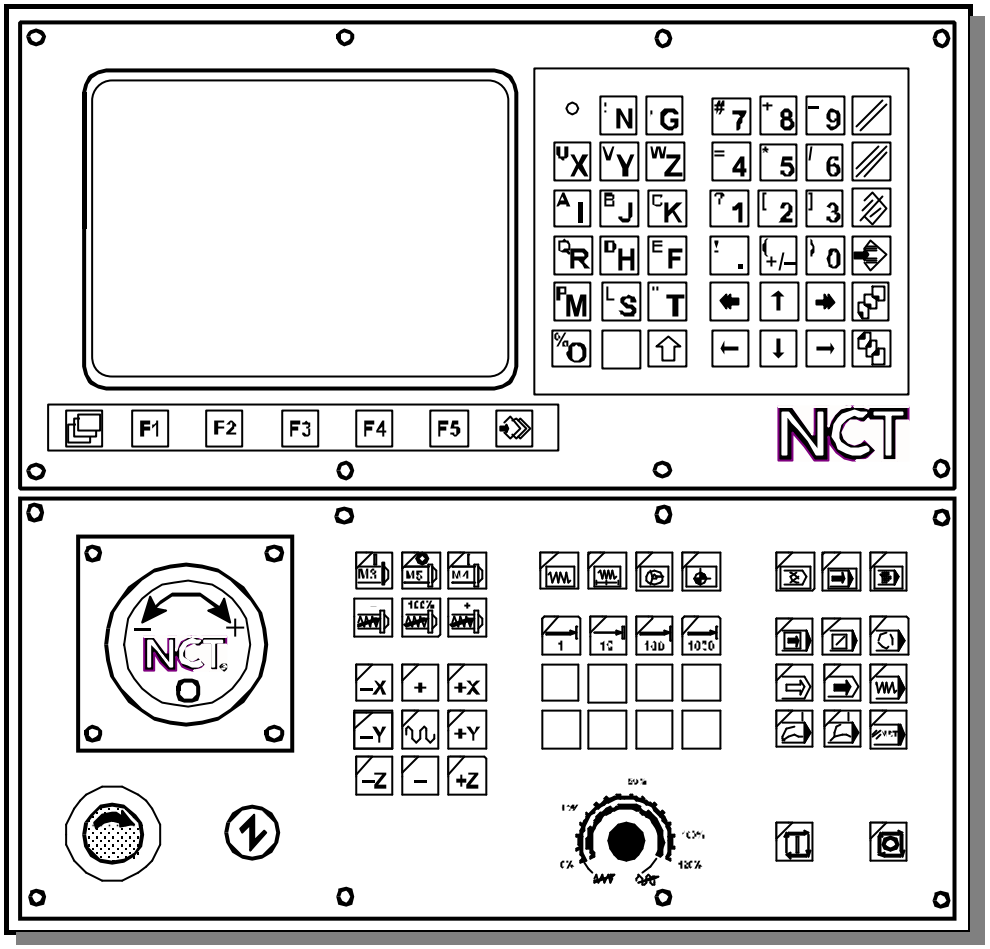


Mounting dimensions of **63-button** alphanumeric **keyboard** mounted under color monitor

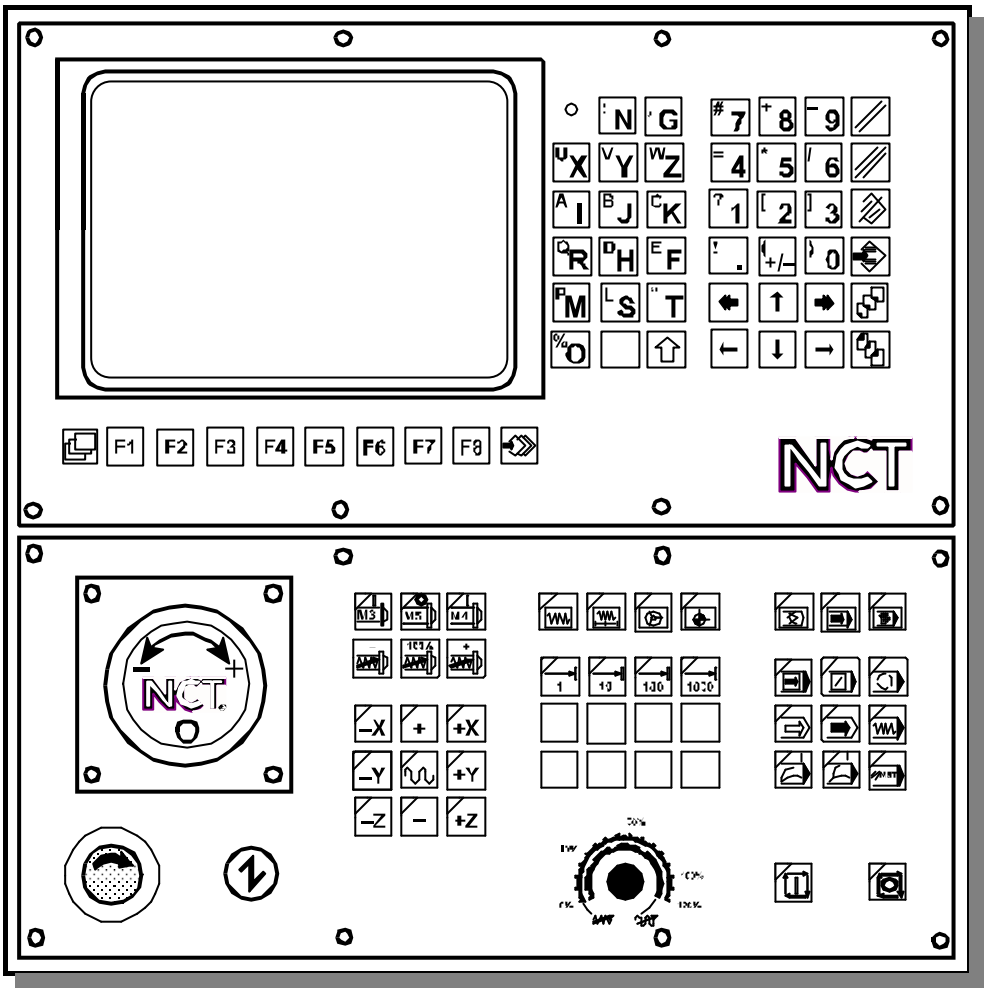


Mounting dimensions of **41-button** alphanumeric **keyboard** mounted beside 15" color monitor

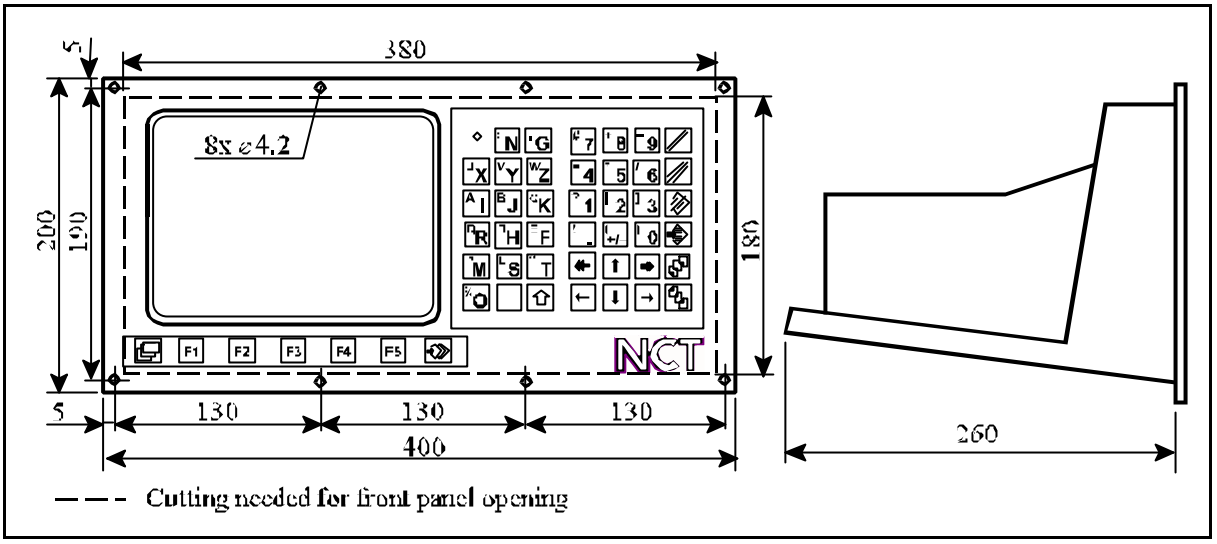
1.1.2 Operator's Panel with Monochrome Monitor



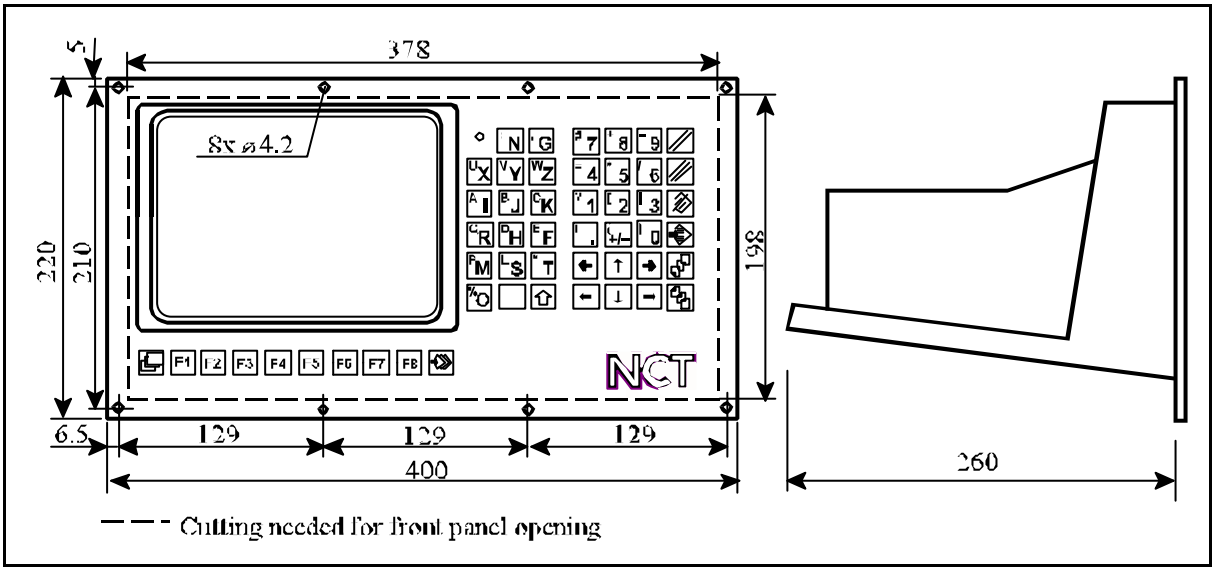
Assembly drawing of **5-softkey** monochrome **monitor** and of compounded **41-button** alphanumeric **keyboard** unit, as well as of optional **machine control panel 2**



Assembly drawing of **8-softkey** monochrome **monitor** and of compounded **41-button** alphanumeric **keyboard** unit, as well as of optional **machine control panel 2**



Mounting dimensions of **5-softkey** 9" monochrome monitor and of compounded alphanumeric keyboard unit



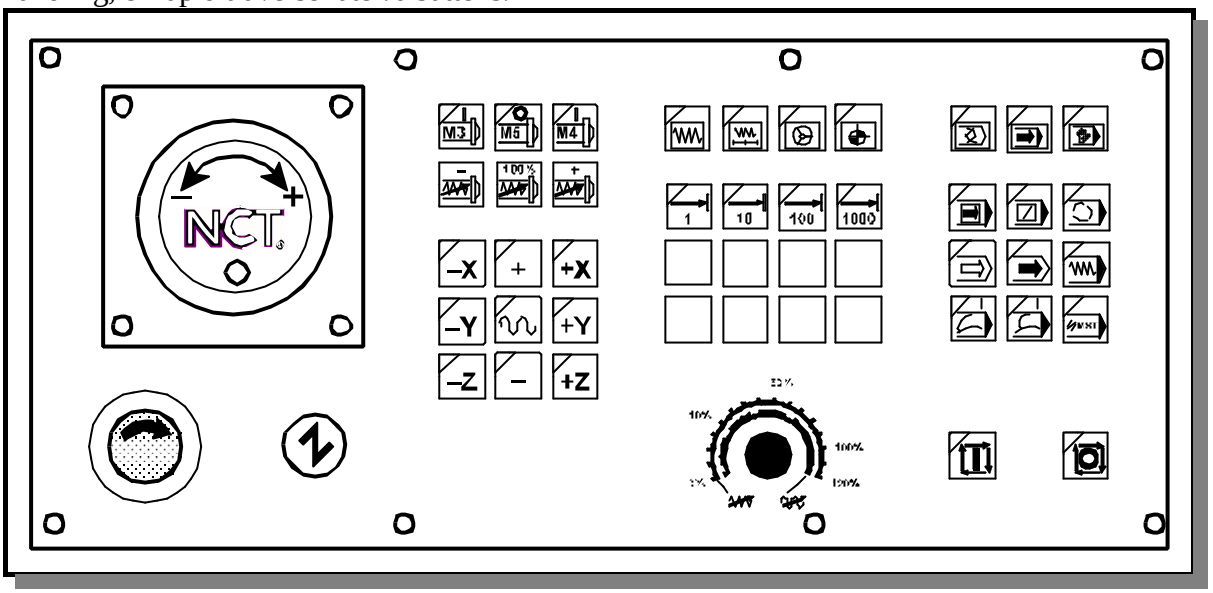
Mounting dimensions of **8-softkey** 9" monochrome monitor and of compounded alphanumeric keyboard unit

☞ ***Warning! The monitor unit must be built as far from transformers and high-voltage cables as possible in order to assure the finest picture quality.***

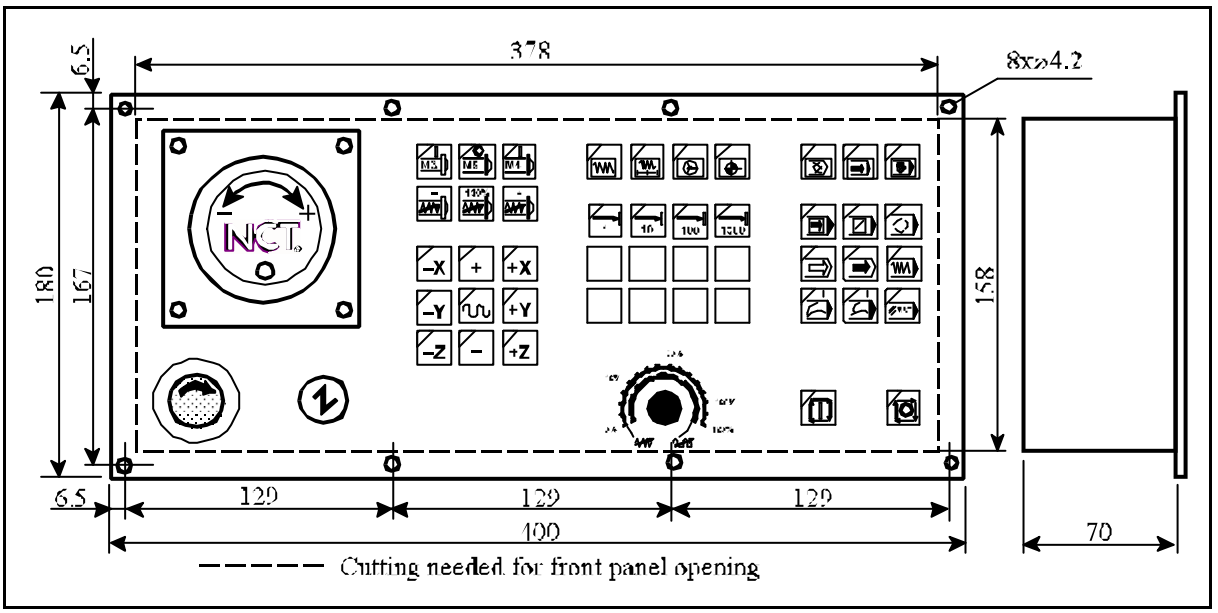
1.1.3 Machine Control Panel 2

The machine control panel, containing buttons of mode switching, jog, spindle rotation, start, stop, ect. is built in by the machine constructor on his own or the machine control panel 2 delivered by NCT is applied.
In the first case the button signals must be connected to the NC through the interface board inputs as well as the button lamps can be lighted through interface board outputs.
In case of using machine control panel 2 the button connections and LEDs are handled by the data input keyboard electronics therefore this mode saves interface I/Os and cabling.

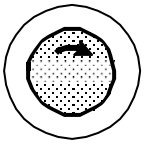
Some elements of machine keyboard can also be operated by means of control softkeys. their detailed description can be found in the Operator's Manual as well as in the PLC Manual.
On the middle field of machine control panel 2 (for special order) buttons with user labels can be placed. These are primarily axis selection buttons (if the number of axes is over 4), buttons controlling coolant handling, or rapid traverse rate % buttons.



Assembly drawing of machine control panel 2



Mounting dimensions of machine control panel 2



Below the operating elements of machine control panel 2 delivered by NCT can be found. The lighted state of LED in top left corner of buttons means that the function selected by the button is active.

Emergency stop. By its depressing the NC registers emergency stop state, shuts down all movements and cuts its outputs off the machine. It can be undone by rotating the

button head in the direction of the arrow.

Machine on button. By affecting it, provided the machine is not in emergency stop state (e.g. the emergency stop is not in held down state) the control and the machine link together. Other parts of the machine, e.g. hydraulics, ect. come into effect.

Mode switching buttons:

continuous jog

incremental jog

manual handle

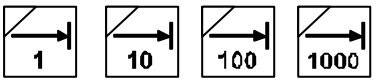
reference point return

edit

automatic

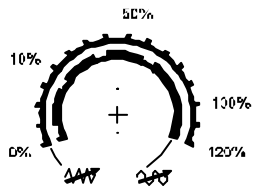
manual data input

Increment buttons:

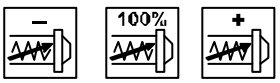


for selecting 1, 10, 100, 1000 increments

Override switches:



Feed rate override switch in the range of 0 - 120%. It can optionally influence the rapid traverse rate. The rapid traverse % scaling (inner circle on diagram) corresponds to the sample PLC program of PLC Manual.



Spindle speed override switches. By affecting – the programmed revolution is reduced, by affecting + it is increased by 10% in the 50-150% range. As the effect of button 100% the programmed

revolution is registered.

Switches modifying the program execution conditions:

single block execution

conditional block stop

conditional stop

program test

machine lock

dry run

block restart

block return

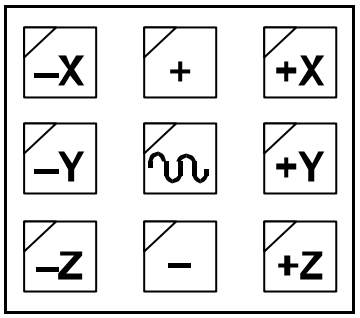
function lock

Start and stop buttons

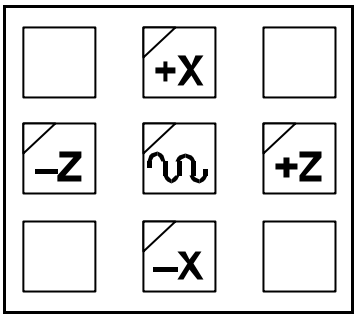
Start button

Stop button.

Jog buttons. Operators of jogging and increment stepping. In case of running to reference point as well as when applying handwheel mounted on front panel they serve for selecting axes. The order of buttons may differ for each machine type.



Order of jog buttons in case of milling control



Order of jog buttons in case of lathe control

The captions and order of jog buttons can be modified in case of special order. See optional buttons of machine keyboard.

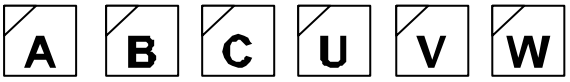
Spindle start and **stop** buttons. By affecting them the spindle starts to spin in direction M3, or M4 as well as stops spinning as the effect of button M5.

1.1.4 Optional Buttons of Machine Control Panel 2

Options of free purpose buttons

Apart from the above buttons the machine control panel contains **8 free purpose buttons** equipped **with LEDs**, about which the machine constructor decides what function he chooses to build in. Below the possible labels that can be ordered are listed:

Axis selection buttons:



If there are more than 4 axes in the machine the axes to be moved must be selected for axis movement, manual handle and reference point return. In this case it is practical to place the axis selection buttons to the option buttons of machine keyboard. In jog mode for example with one of the buttons (e.g.: W) the desired axis can be selected, while with button + or – the direction is specified

Rapid traverse rates:

The **rapid traverse rate** can be selected with the help of four buttons, optionally.

Spindle jog mode:

This button activates the spindle jog mode. In this mode the spindle can be rotated slowly with buttons M3, M4. Till button M3 or M4 is held down the spindle jogs, if it is let the spindle stops.

Coolant handle buttons:

1st choise:

M8: if auto mode M8 is off the operator can switch the coolant on by means of this button. The switched-on state of the LED signals the switched-on state of coolant pump.

M9: if auto mode M8 is off the operator can switch the coolant off by means of this button. The switched-on state of the LED signals the switched-off state of coolant pump.

Auto mode M8: if the mode is on (lighted LED) the coolant pump is switched on or off by means of commands M8, M9 of the part program. In case the mode is off the operator switches the coolant on or off with the help of buttons M8, M9.

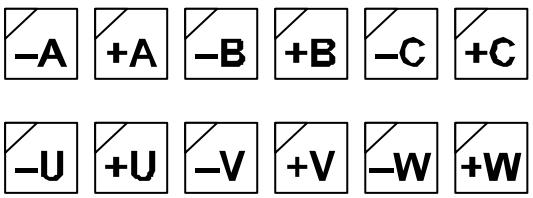
2nd choise:

M8_M9: if auto mode M8 is off the operator can switch the coolant on or off by means of this button. The switched-on state of the LED signals the switched-on state of coolant pump.

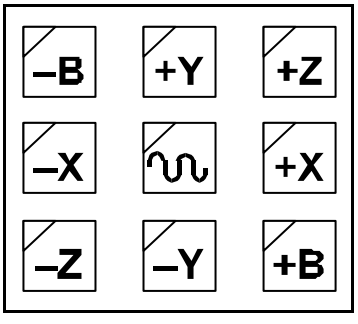
Auto mode M8: if the mode is on (lighted LED) the coolant pump is switched on or off by means of commands M8, M9 of the part program. In case the mode is off the operator switches the coolant on or off with the help of button M8_ M9.

Options of jog buttons:

Apart from the ones listed in the previous chapter the jog buttons can be labeled as follows:



For example, in case of a horizontal milling machine, on which rotary table B is also found the jog buttons can be ordered in the following way:

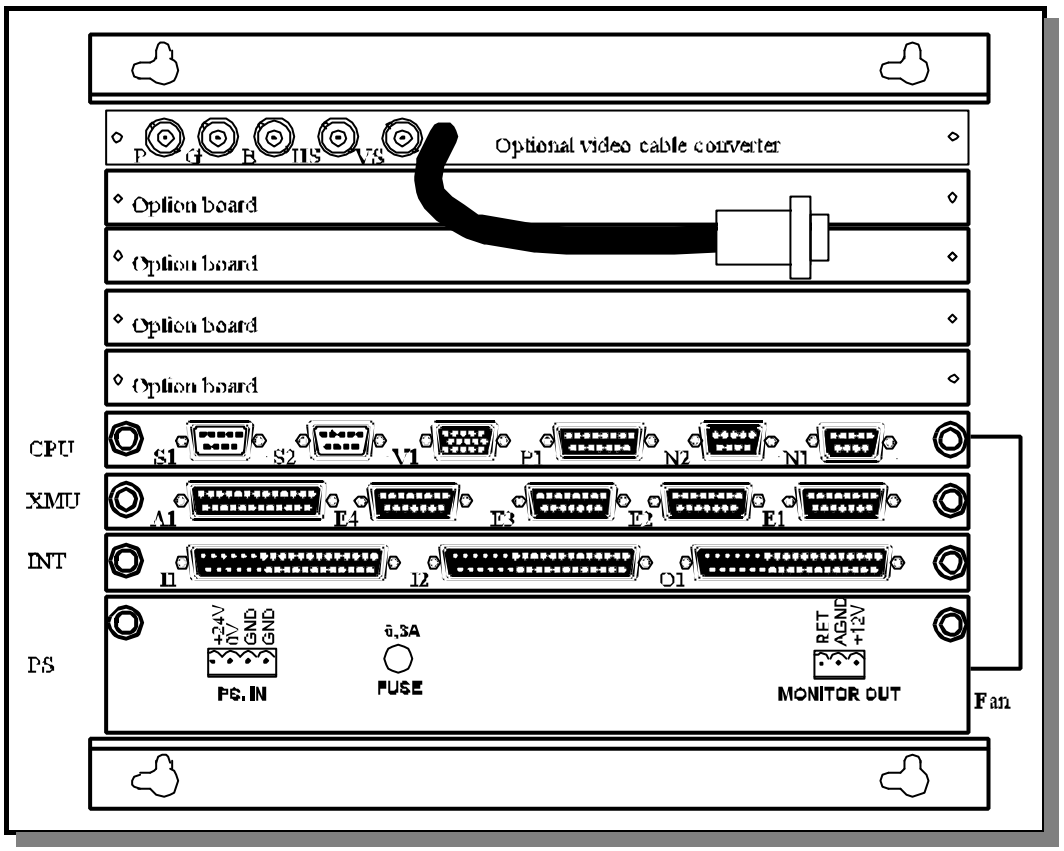


1.2 Components and Mounting Dimensions of Logic Unit of NCT99

The following PCBs can be placed in the logic unit of NCT 99 controls:

CPU (central processing unit) board: 1.
XMU (measuring system) boards: 1-3.
INT (interface) boards: 1-4.
PS (power supply) board 1.

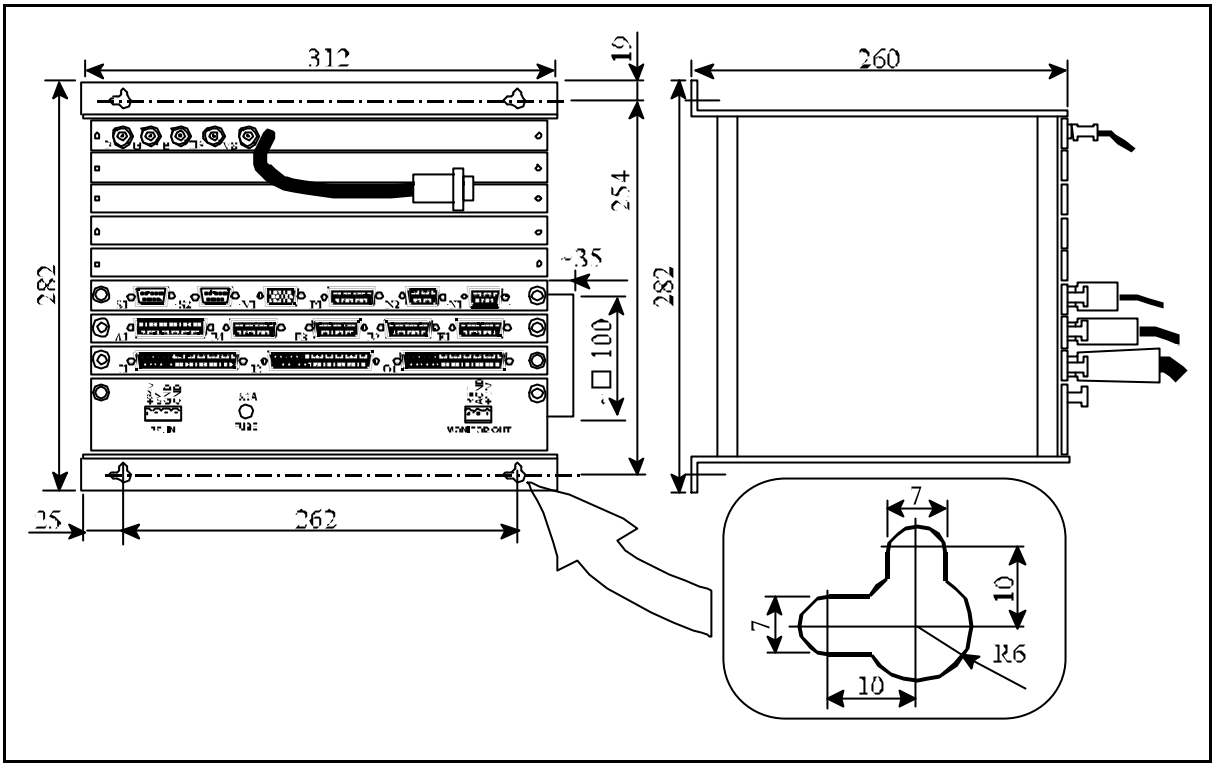
In case of standard control structure 1 of each board type must be placed in the logic unit.
The video cable converter unit, occupying 1 board place can be built in the RACK, optionally.



Assembly drawing of logic unit

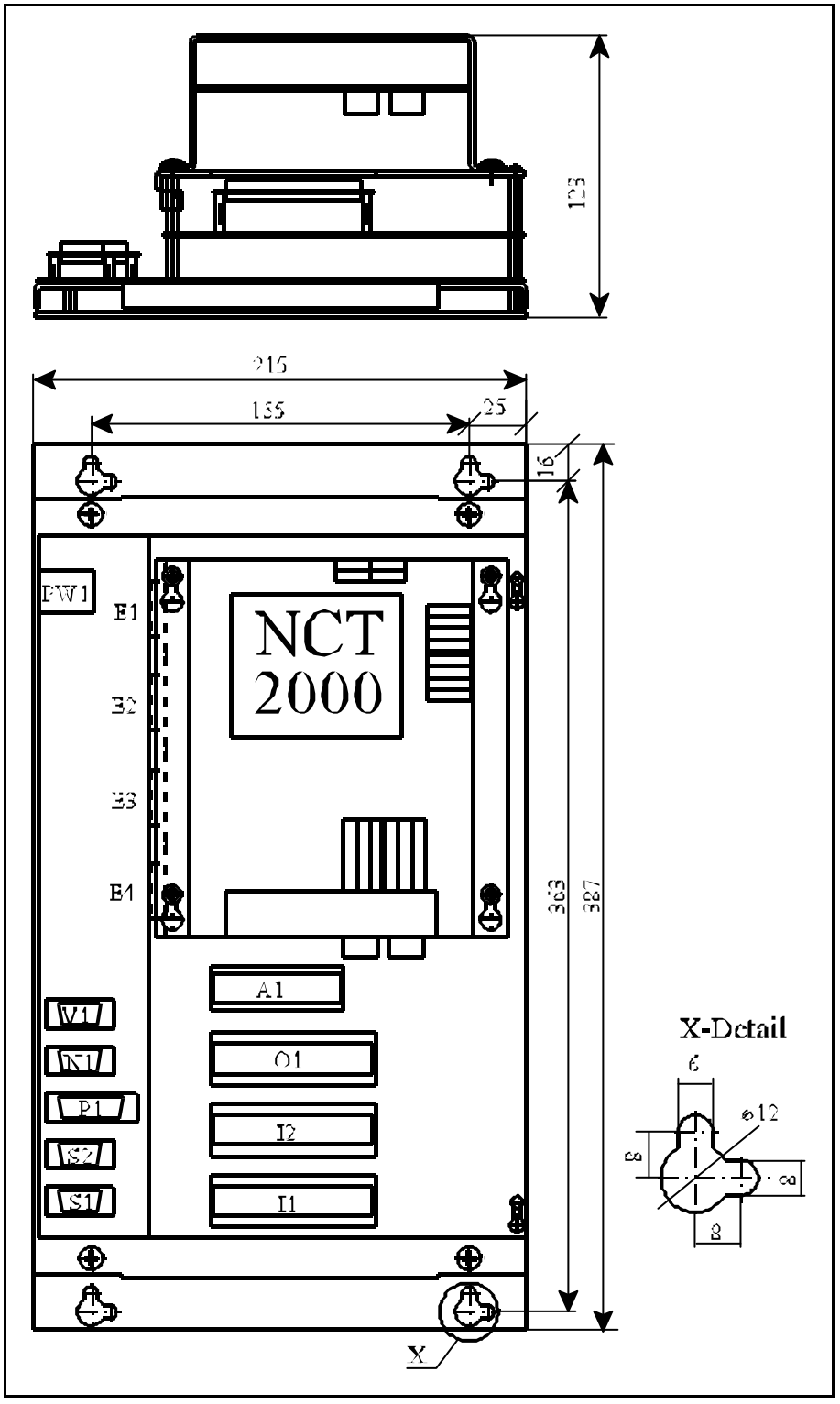
Note: Provided the XMU board is ordered with TACHO option board the XMU board occupies 2 board places in the logic unit.

The configuration and connection of each board type is dealt with in separate chapters.



Mounting dimensions of logic unit

1.3 Components and Mounting Dimensions of Logic Unit of NCT2000

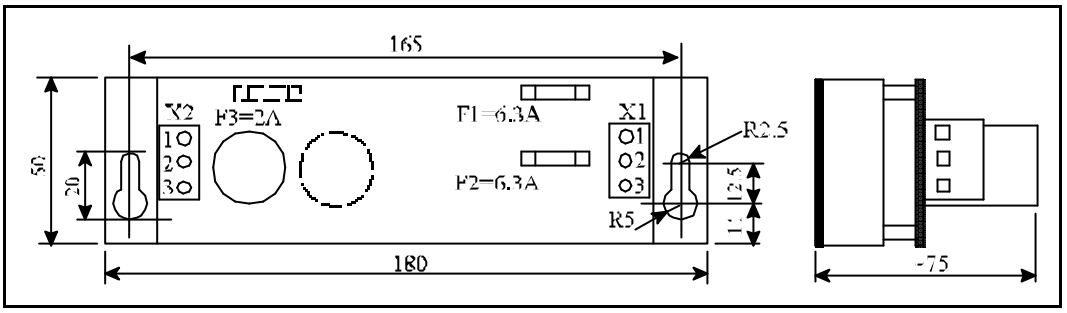


Mounting Dimensions of Logic Unit of NCT2000

1.4 Accessories and Options

1.4.1 Mounting dimensions of ACDC Rectifier Circuit (Accessory)

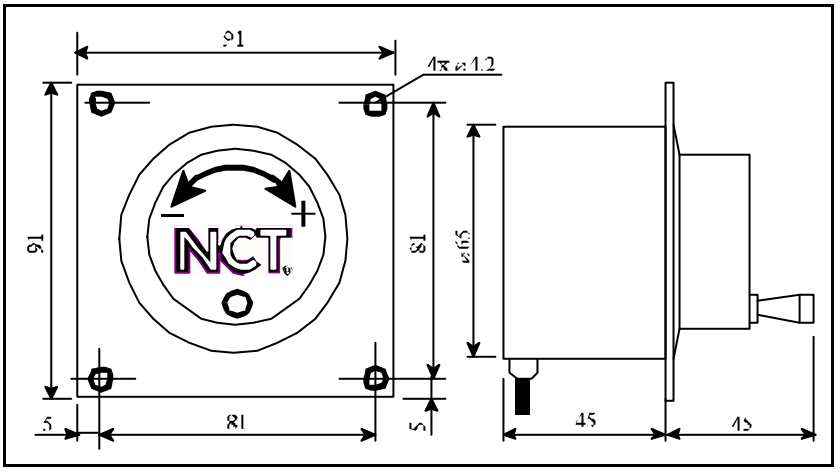
The ACDC rectifier unit is used for the supply of logic unit and operator's panel.
It can be also used optionally (for special order) for the supply of interface relays and I/Os of INT boards.
The two delivery modes:
– it only transmits rectified and filtered supply voltage 6.3A (it is used for control supply)
– it transmits rectified and filtered supply voltage 4A and regulated supply voltage 2A 24V.



Mounting dimensions of ACDC rectifier unit

1.4.2 Wall Mountable Handwheel (Option)

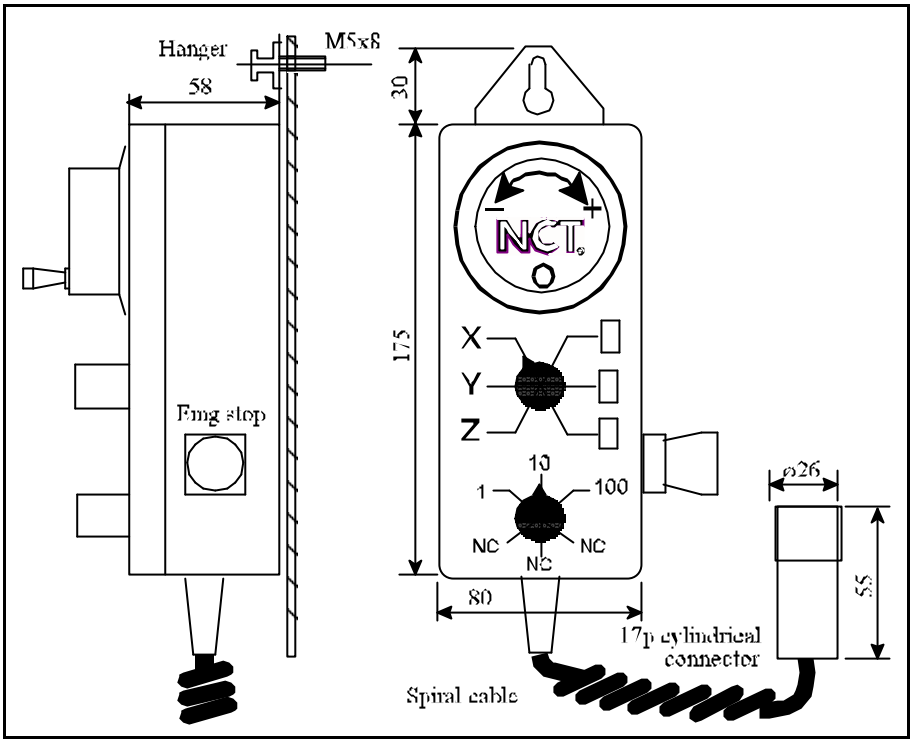
The handwheel to be mounted on a front panel may be built in machine control panel 2 as well as mounted on a suitable place on the machine.
The unit is delivered with a 400-mm-long cable and a *25 contact Dsub male* connector, which can be directly plugged into connector H1 of machine control panel 2.



Mounting dimensions of wall mountable handwheel

1.4.3 External Handwheel (Option)

The following operating elements can be found on the external handwheel:
handwheel,
axis selector switch,
increment selector switch,
emergency stop button.
The axis switch has 6 states meaning, maximum 6 axes can be selected. The names of further axes can be written in 3 windows on the right side of switch board behind the foil.
The handwheel casing can be hanged onto the accessory screw.

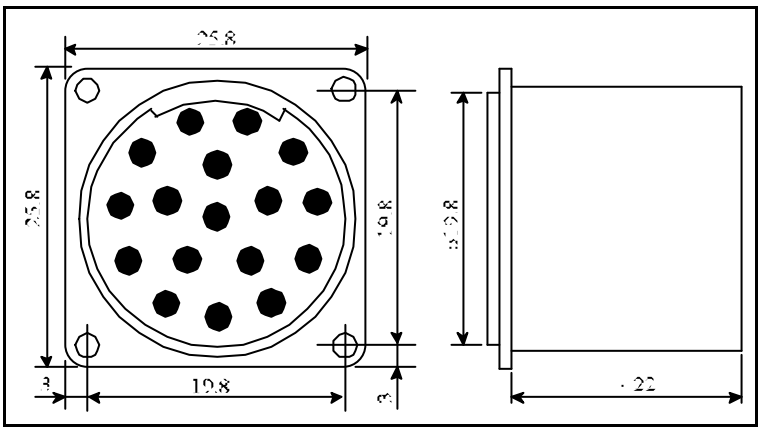


External handwheel

The external handwheel signals are tied to a *17 contact cylindric* connector. The connector counterpart (nut) is mounted on a suitable place on the front panel by the machine builder, *max. 500mm* far from machine control panel 2. The 17 contact cylindric nut must be cabled to handwheel connector 25 contact Dsub on machine control panel 2.

Mounting options of external handwheel

The spiral cable tying the handwheel casing and the 17 contact cylindric connector together can be lengthened
3m long for standard,
6m long optionally.

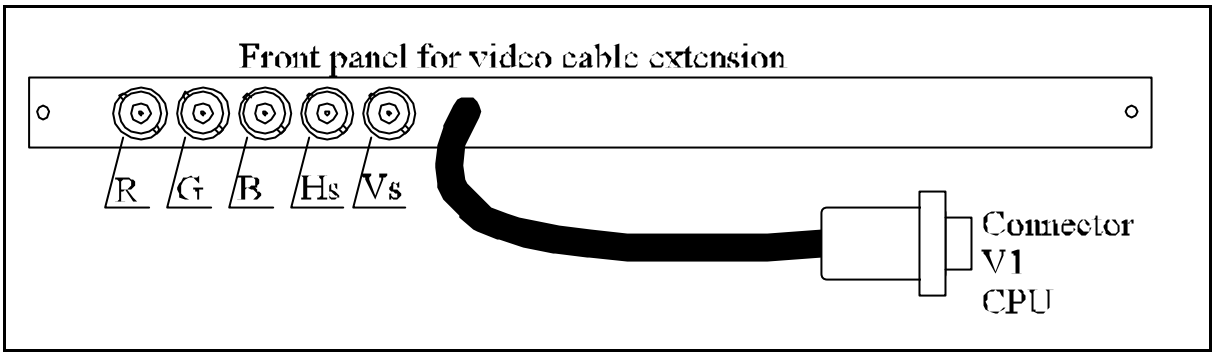


Sizes of 17p cylindric connector mounted on front panel

1.4.4 Extension Assemblies of Color Video Cable (Option)

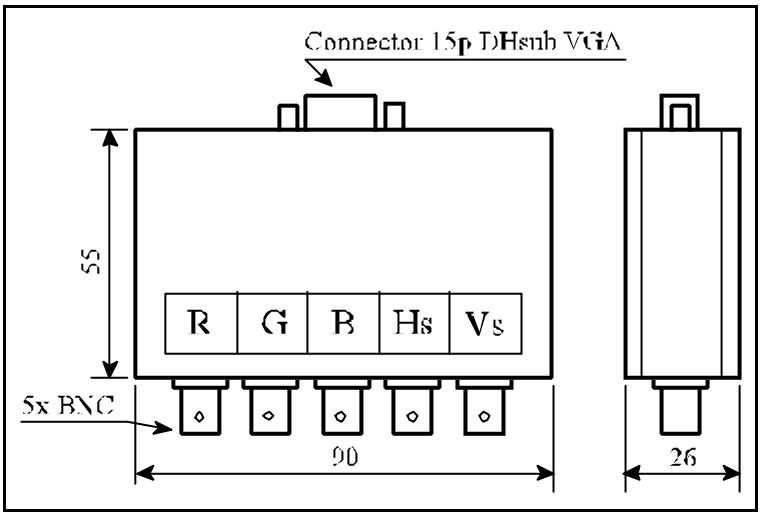
If the appr. 1m-long video cable delivered along with the color monitor does not reach connector V1 of logic unit CPU board then extension can only be executed by means of a 75Ω coaxial cable in order to ensure the optimal picture quality.
Therefore the following optional assemblies are at disposal:

extension front panel built in logic unit RACK (occupying1 board place),
cable converter box to be placed beside the monitor.



Optional extension assembly of logic unit video cable

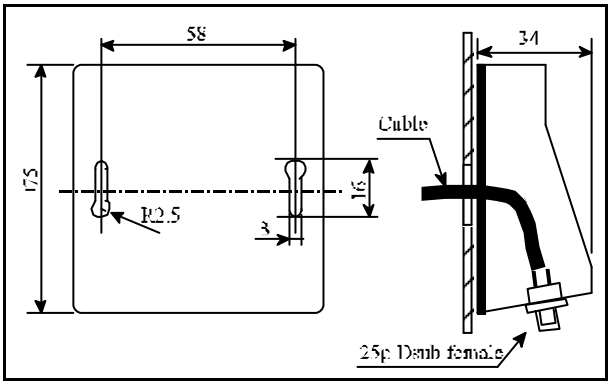
The cable mounted with *15p DHsub male* VGA connector hanging out from the front panel built in RACK must be plugged in video connector V1 of CPU board logic unit. The assembly divides video signals (R, G, B, Hs, Vs) to 5 separate *BNC* connectors.
From there the signals are transmitted to the monitor unit with the help of a *75Ω coaxial* cable.
The cable converter box placed beside the monitor receives the signals through *BNC* connectors and gathers them to a standard *15p DHsub female* VGA connector. The cable coming from the monitor can be plugged into this connector.



Cable converter box

1.4.5 Serial Port Connection Box (Option)

The box can be mounted on a suitable place. The box contains a *25 contact Dsub female* connector, to which S2 serial interface connector signals of CPU board can be sent.



Serial port connector box

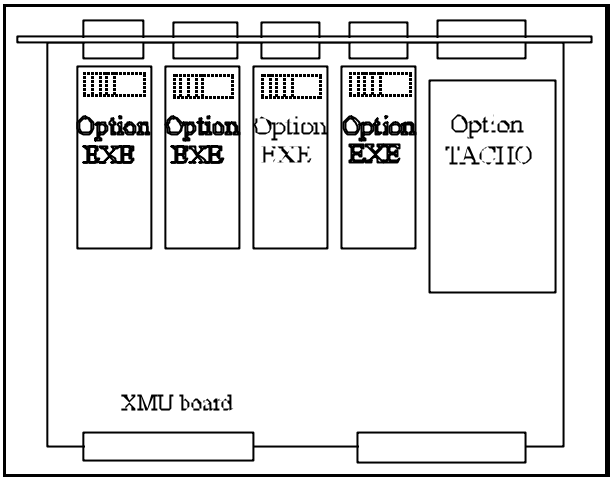
1.4.6 EXEI or EXEV Option Board for Receiving Sinusoidal Encoder Outputs

The XMU board is able to receive sinusoidal encoder outputs when building an option board for each axis in. By applying the boards the occupation of XMU measuring system board in RACK is not increased. For details see XMU board description.

There may be two kinds of sinusoidal outputs received:

Current signal of **11μA$_{pp}$** is received by **EXEI** option board, while

voltage signal of **1V$_{pp}$** is received by **EXEV** option board.



1.4.7 TACHO Option Board for Generating Tacho Output

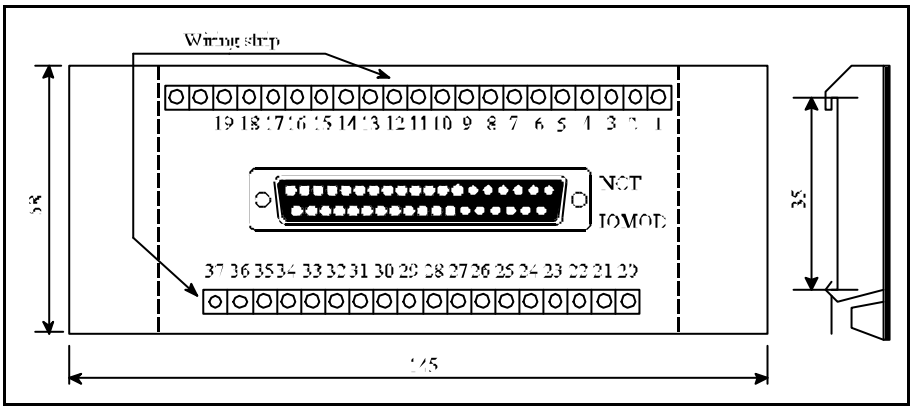
The TACHO board, generating analog tacho output from encoder signals by means of frequency - voltage coversion, can be mounted optionally on XMU measuring system board. If the optional TACHO board is used the occupation of XMU board in RACK is 2 board places. For details see XMU board description.

The optional TACHO board can only be used in case rotary encoder is applied for path measure and the encoder is fixed directly to the motor axis.

1.4.8 IOMOD Snap on Unit for 35mm DIN rail (Option)

In the unit a *37 contact Dsub female* connector can be found, the signals of which are led to the appropriately numbered wiring strip points.

The Dsub connector can be tied together with any interface (INT) board connector of logic unit by means of ribbon cable (ordered optionally in 1-2m length).

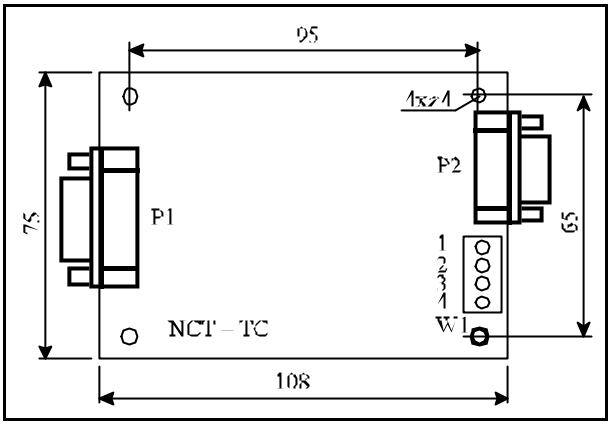


IOMOD unit snapped on 35mm DIN rail

1.4.9 NCT–TC Probe Interface Unit (Option)

If for 99M milling control a probe put in spindle or mounted on table for tool length measurement is to be applied or tool length sensor is to be set to 99T lathe control the NCT–TC PCB solves the interface.

The interface unit must be mounted as near to the probe as possible in order to minimize error problems. (For example spindle housing.) The interface unit can be fixed with the help of four spacers.



Interface unit of NCT–TC probe (option)

2 CONNECTIONS OF CONTROL

2.1 Power Supply

The following units of control need supply voltages:

monitor
alphanumeric keyboard
logic unit and
INT (interface) board.

2.1.1 Monitor Supply

The monitor supply depends on the applied monitor:

color monitors operate with *100 – 240 V AC*; *50/60 Hz*; *1.5 – 0.7 A* voltage.

The monochrome monitor supply is ensured by the PS (power supply) board of logic unit. (See also description of the different monitor units).

2.1.2 Alphanumeric Keyboard and Logic Unit Supply

The logic unit and the alphanumeric keyboard need rectified and filtered direct voltage. The rectifying and filtering is executed by the control accessory ACDC rectifier unit.

24 V AC
100 VA

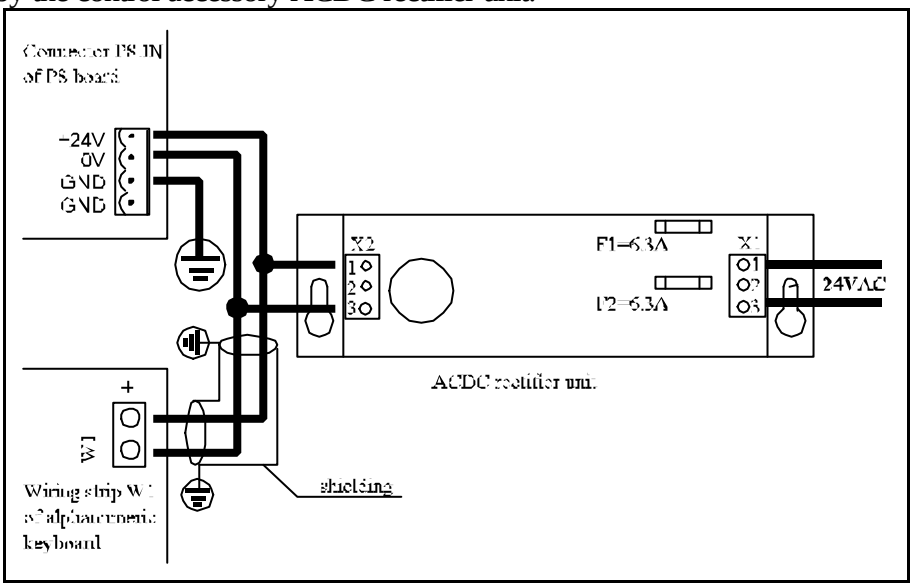
voltage must be plugged to wiring strip with reference designation X1 of rectifier unit. The secondary coil of transformer is secured by 2

6.3A

fuses signaled

F1 and F2.

35V can be measured between the outputs of rectifyier unit without load.



Power supply of alphanumeric keyboard and logic unit

Positive voltage runs on point No. 1 of wiring strip X1, while
negative voltage runs on position No. 3 of wiring strip X2.

This voltage must be plugged into input +24V and 0V of connector PS.IN of logic unit PS board, as well as to the wiring strip W1 of alphanumeric keyboard. ***Use shielded cable for supplying the alphanumeric keyboard for the best noise suppression.***

☞ *Warning!* *Never plug negative end of input voltage to input GND of connector PS.IN of logic unit PS board, because it may demage the device!*
Likewise it is forbidden to connect input 0V of connector PS.IN, or position No. 3 of connector X2 of ACDC unit to the ground.
It is forbidden to plug other current consumer, e.g. machine interface relay band to this supply!

Input GND of connector PS.IN of logic unit PS board must be connected to the earth ground of the machine.

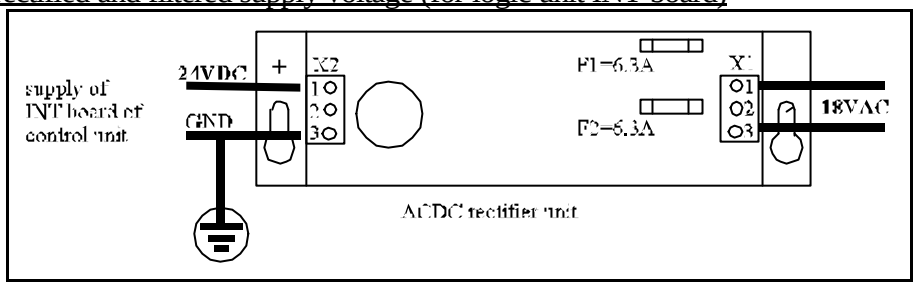
2.1.3 INT (Interface Board) and Machine Interface Supply

INT (interface) board I/Os need 24VDC rectified and filtered supply voltage. (INT board does not need regulated 24V.)
The supply can also be ensured from optionally delivered ACDC rectifier unit. *Never operate INT boards and the relay band of machine interface from the rectifier unit ensuring the supply of logic unit and alphanumeric keyboard!*

Two kinds of ACDC converter units are delivered to the inteface:

– it only transmits 6.3A rectified and filtered supply voltage (for logic unit INT board)

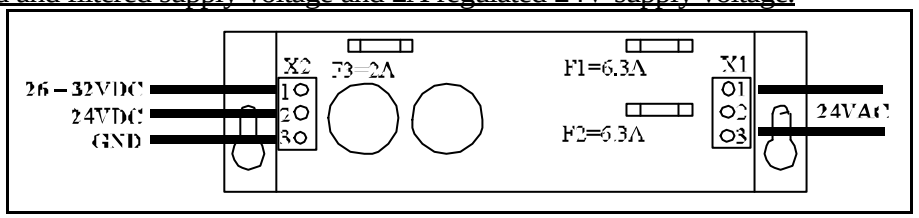
In this case *18VAC* alternating current must be plugged to the rectifier unit input (wiring strip X1 position No. 1 and 3). This way the voltage between X2 wiring strip position No. 1 and 3 is appr. 24V. Plug position No. 3 of wiring strip X2 to the ground.



Supply of INT (interface) boards with the help of ACDC unit

– it transmits 4A rectified and filtered supply voltage and 2A regulated 24V supply voltage.

In this case *24VAC* alternating current must be connected into the rectifier unit input (wiring strip X1 position No. 1 and 3).



The ACDC unit assembled with voltage regulator

This way the voltage between X2 wiring strip position No. 1 and 3 is appr 26 – 32V depending on the load. the regulated voltage between X2 wiring strip position No. 1 and 3 is 24V. The regulated voltage is secured by fuse F3 2A. Plug position No. 3 of wiring strip X2 to the ground.

2.2 NCT CAN Bus and Its Topology

The logic unit forms connection with the different units (e.g.: operator's panel, NCT drive) through a standard serial bus, namely through CAN bus (CAN: Control Area Network). The logic unit is capable of handling two separate CAN buses. The connectors of units connected to the first CAN bus are marked N1, those of units connected to the second one are marked N2. The connectors mounted on the different units are *9 contact Dsub female* connectors.

Signal transfer rate on bus:

1 Mbit/sec.

Maximum cable length:

30 m

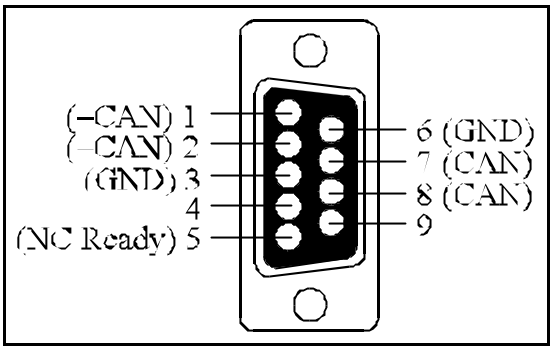
TTL-level signals CAN and –CAN are sent and received by CAN transceiver. The cable suitable for CAN bus is:

shielded cable with twisted pair.

Both ends of bus must be closed with

120 Ω

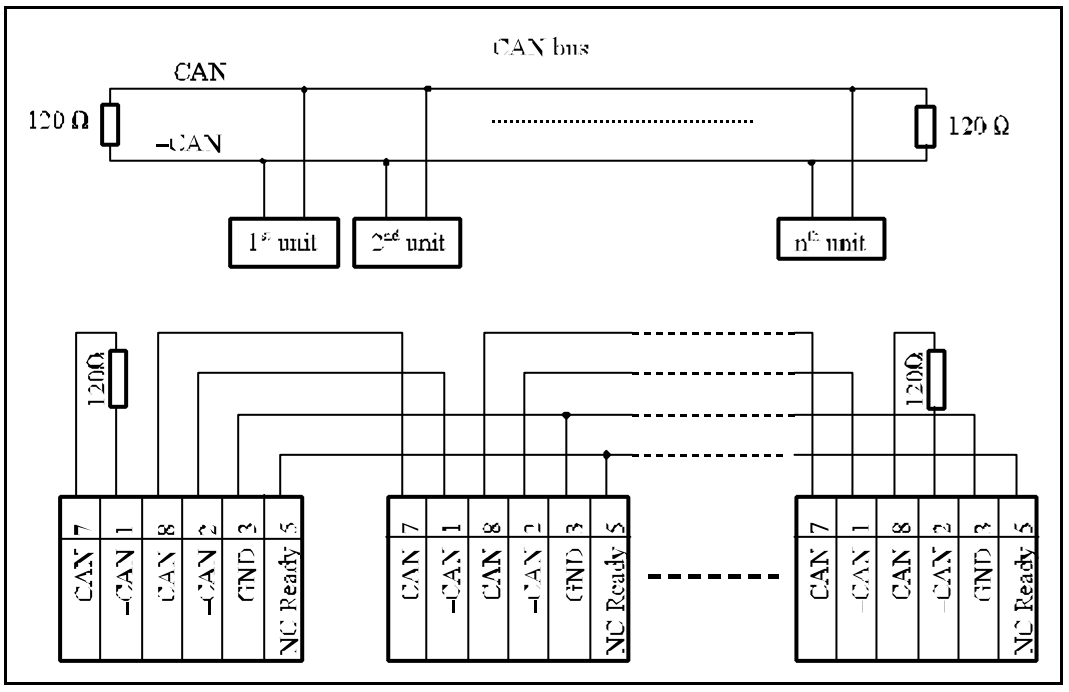
resistance.



Plugging CAN connectors

Signals CAN and –CAN are duplicated in CAN bus connectors.

Apart from standard signals CAN, –CAN and GND NCT CAN bus also contains signal NC Ready. Signal NC Ready is the open collector output of logic unit, which is set to 0 when NC is ready. If the watchdog timer of logic unit desynchronizes the signal is interrupted. The control is ready when the LED on the alphanumeric keyboard is on.



Topology and plugging of CAN bus

2.3 Connection of Color Monitor Unit

The connection of 14" and 15" monitor units corresponds.

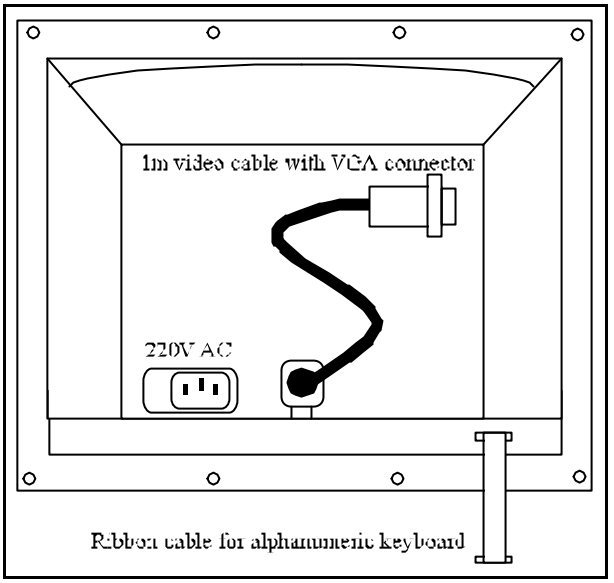
☞ ***Warning!*** ***The monitor unit must be set up as far from transformers and high-voltage wires as possible in order to ensure the finest picture quality.***

2.3.1 Color Monitor Supply

Color monitor unit supply occurs from

100 – 240 V AC
50/60 Hz
1.5 – 0.7 A

alternating current, which can be plugged into the unit through standard net connector placed in the monitor back.



Connections of color monitor unit

2.3.2 Connection of Video Input

The approximately-1-m-long video cable found in the monitor unit is mounted with standard *15p DHsub male VGA* connector and can be directly plugged into connector V1 of logic unit CPU board.

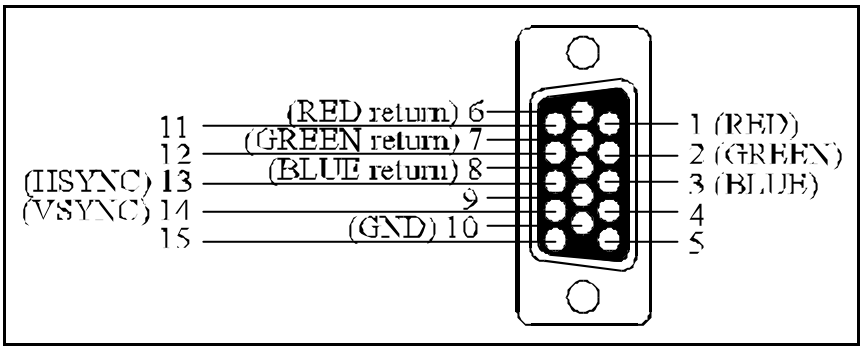
2.3.3 Video Cable Extension

Provided the logic unit is farther from the monitor than 1m the cable must be extended. The units for extension delivered by NCT are discussed in chapter 1.4.4 on page 25. The signals must be transferred in

75 Ω coaxial cables

for extension. The signal transmission is satisfactory for appr.

30 m.



Pin assignment of color monitor video connector

☞ ***Warning!*** ***Cables transmitting video signals must be set up as far from transformers and high-voltage (e.g. motor) wires as possible in order to ensure the finest picture quality.***

2.4 Connection of Monochrome Monitor Unit

☞ ***Warning! The monitor unit must be set up as far from transformers and high-voltage wires as possible in order to ensure the finest picture quality.***

2.4.1 Monochrome Monitor Supply

Monochrome monitor unit supply occurs from

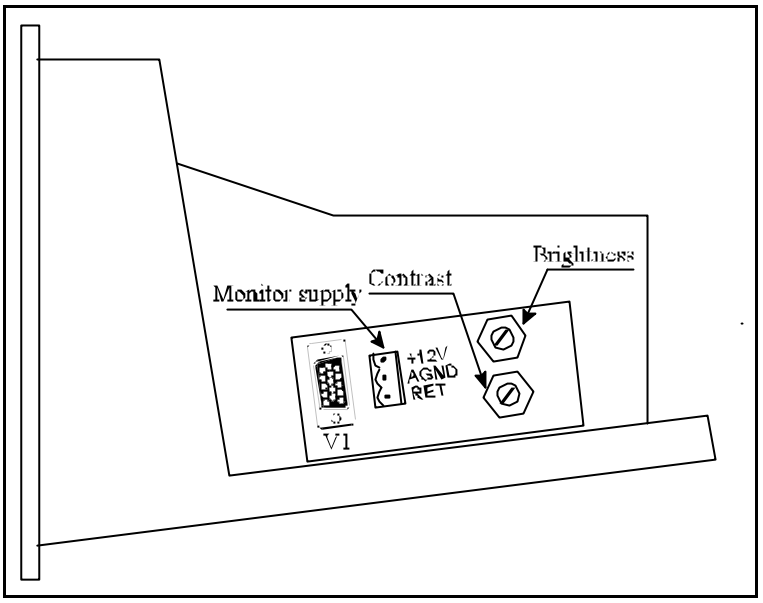
12V DC regulated

2 A_{max}

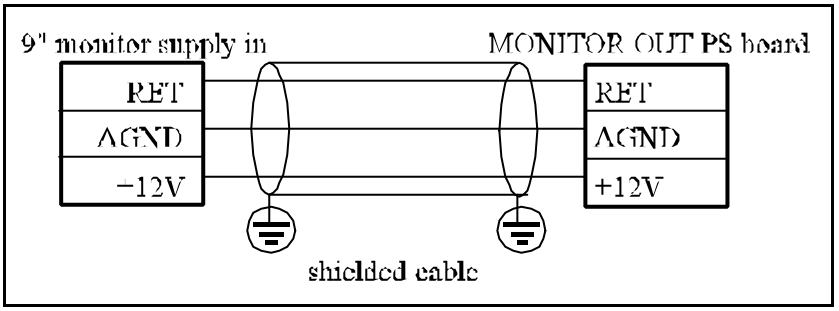
supply voltage. It is gained from output MONITOR OUT of logic unit PS board.

0V must be returned through input RET for the regulator in power supply thus regulation is done in the monitor. Therefore always 3 wire cable must be used for monitor supply.

Use shielded cable for supplying the monitor for the best noise suppression.



Connectors on monochrome monitor

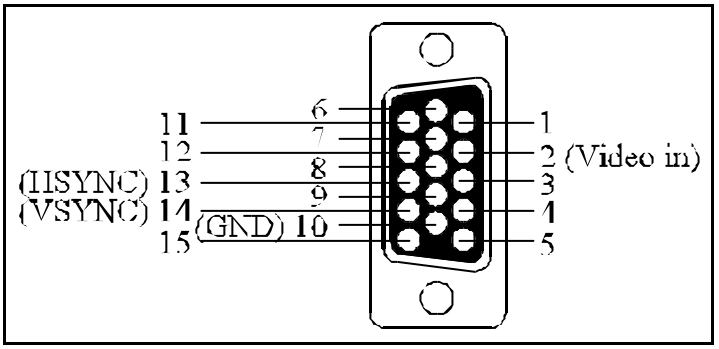


Connecting monochrome monitor supply

2.4.2 Connection of Video Input

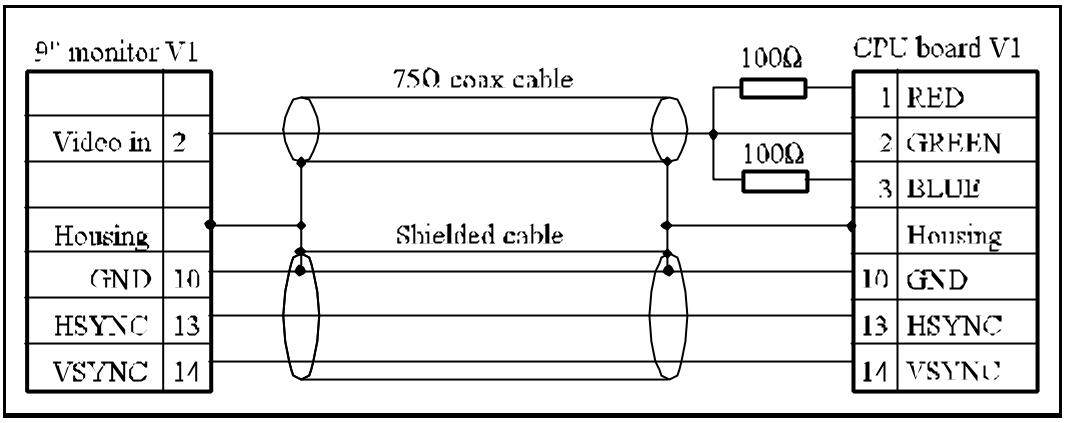
The connection of *15p DHsub male* connector V1 mounted on the side of monochrome monitor is seen on the enclosed diagram.

This connector must be connected to connector V1 of CPU board. The advised connection is shown by the enclosed diagram. The video signal can



Pin assignment of video connector V1 of monochrome monitor unit

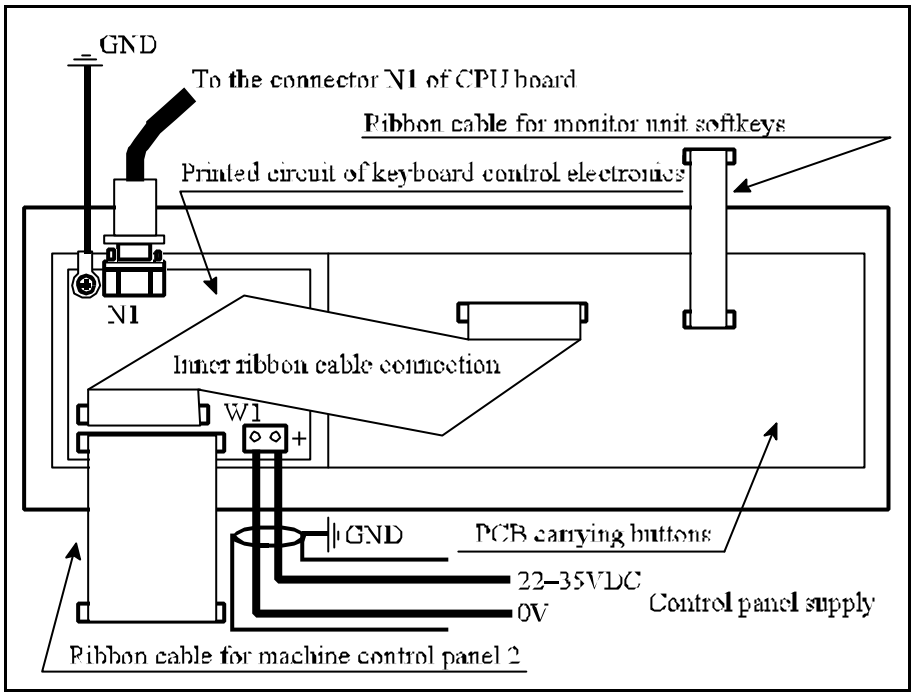
be mixed for the monochrome monitor with the help of two 100Ω resistances from output signals R, G, B on the side of CPU board.
The video signal must be transmitted through 75Ω coaxial cables, while it is enough to carry synchron signals in shielded cables.



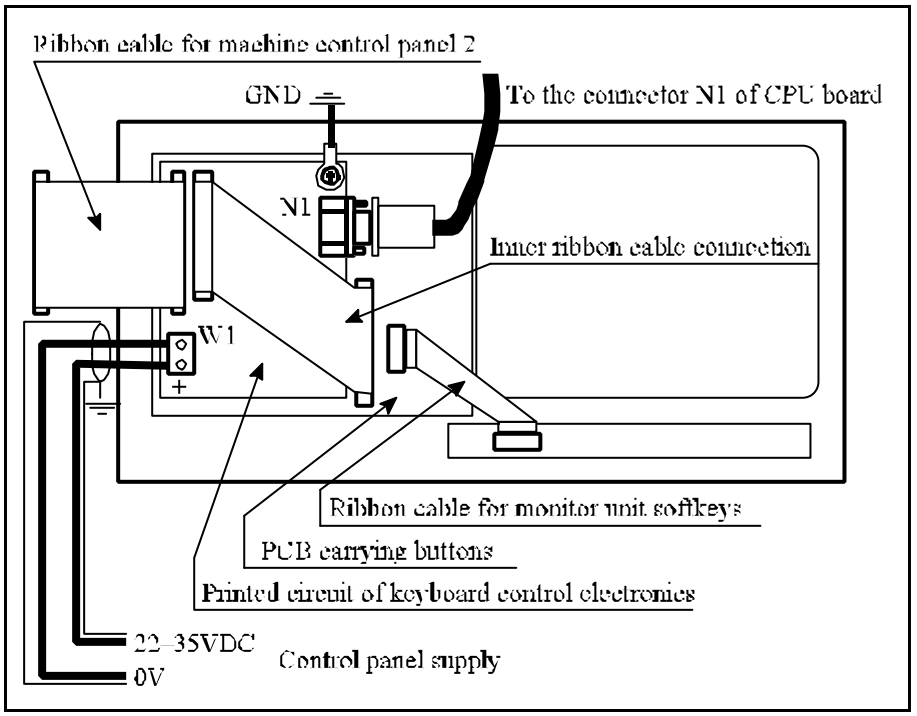
Connecting monochrome monitor to CPU board video output

☞ ***Warning! Cables transmitting video signals must be set up as far from transformers and high-voltage (e.g. motor) wires as possible in order to ensure the finest picture quality.***

2.5 Connections of Alphanumeric Keyboards



Connections of alphanumeric keyboard mounted under color monitor



Connections of alphanumeric keyboard compounded with monochrome monitor

2.5.1 Supply and Ground-connection of Alphanumeric Keyboard

Supply

Operator's panel supply needs

22 – 35 V DC

300 mA_{max}

current.

The operator's panel supply can be taken from the rectifier also feeds the logic unit and can be tailed through wiring strip W1. See also chapter 2.1.2 on page 28.

Shielding

Use shielded cable for supplying the alphanumeric keyboard for the best noise suppression.

Ground-connection

The operator's panel electronics must be grounded as seen on the diagram. *Its negligance may result in insecure operation.*

2.5.2 Inner Connections

The keyboard control electronics PCB is connected

to the PCB of buttons with *40 contact ribbon cable connector*, as well as

to optional machine control panel 2 with *50 contact ribbon cable connector*.

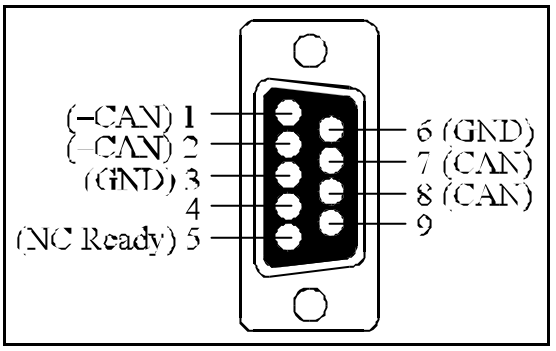
The monitor unit softkeys are connected to the PCB of buttons

with 14 contact ribbon cable connector.

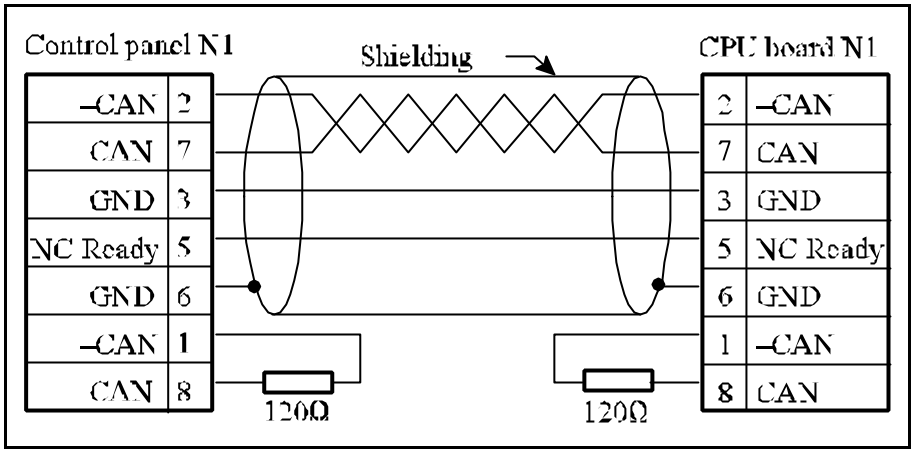
*Ribbon cable*s are part of control accessories.

2.5.3 Linking Operator's Panel and Logic Unit

The linking of operator's panel and logic unit is implemented through *9 contact Dsub male* connector of N1 CAN bus on the PCB of alphanumeric keyboard control electronics. In case only these two units exist on CAN bus No. 1, 120 Ω closing resistance must be built on both the operator's panel and the CPU side.



Pin assignment of connector N1



Connecting operator's panel and logic unit through CAN bus

2.6 Connections of Machine Control Panel 2

Machine control panel 2 is connected to the control electronics on alphanumeric keyboard by means of a 50 contact ribbon cable.

The two buttons on keyboard connected by the user are:

Machine on button

A *normally open contact*, a *normally closed contact* and a *LAMP* can be found on the button.

Operating Voltage (max):

U_{max}*: 250V AC*

Current Rating (max):

I_{max}*: 6A AC*

LAMP ratings (max):

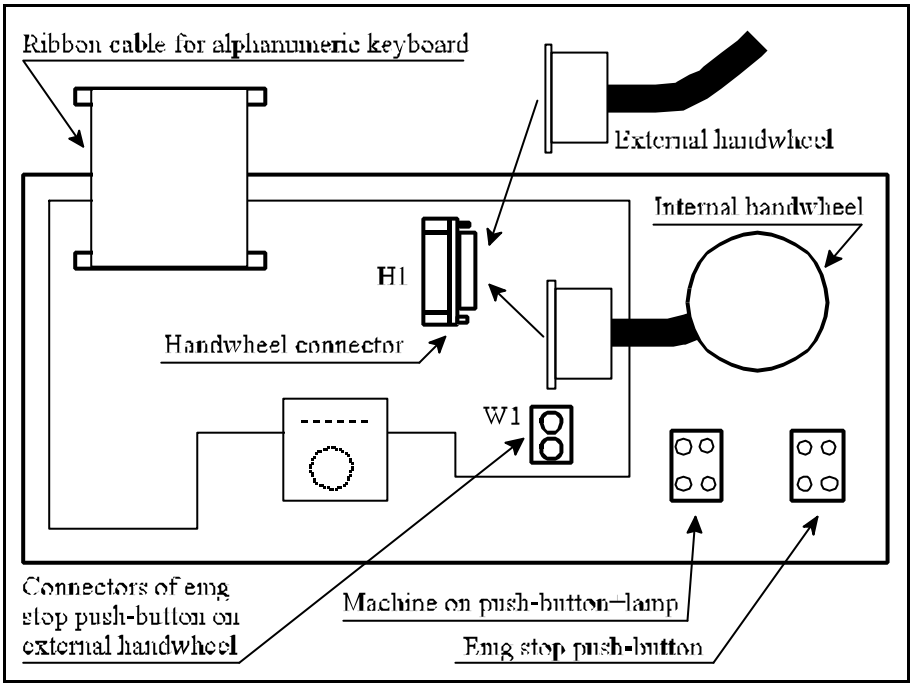
U_{Lamp}*: 24V; 2.5W*

Emergency stop button

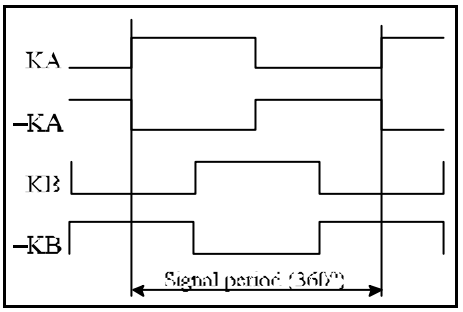
A *normally open contact* and a *normally closed contact* can be found on the button.

Operating Voltage (max):

U_{max}*: 250V AC*



Connections of machine control panel 2



Handwheel signals

Current Rating (max):
I_{max}: *6A AC*

2.6.1 Pin Assignment of Handwheel Connector H1

The handwheel is tailed to the control through H1 *25 contact Dsub female* connector. There are two types of handwheels:

handwheel *mounted on machine control panel*, as well as
external handwheel.

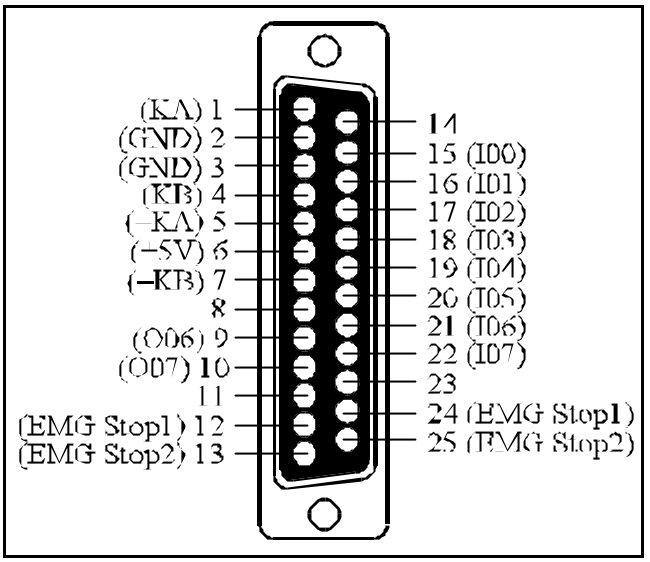
The handwheel mounted on the front panel uses the following signals:

KA, –KA, KB, –KB, +5V, GND.

Level of signals:

TTL

The connection of not signals is not obligatory. The handwheel mounted on the front panel is delivered with a 25 contact Dsub male connector, which can be directly plugged into connector H1. (See chapter 1.4.2 on page 23..)

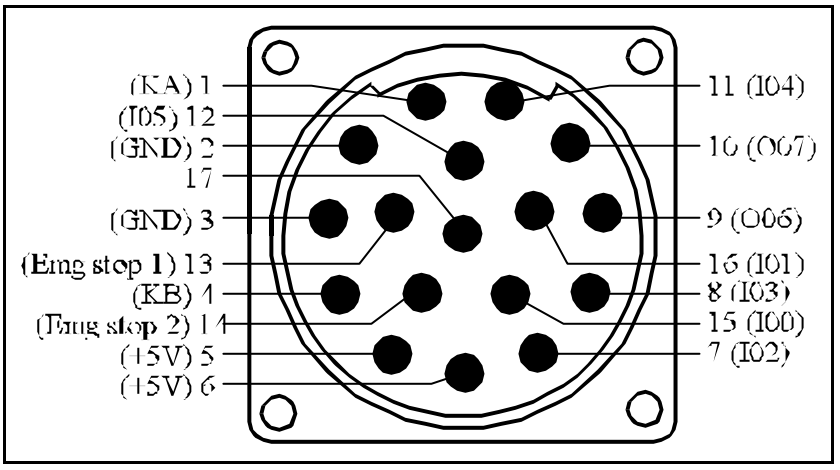


Pin assignment of connector H1

2.6.2 Connection of External Handwheel

For the sizes and structure of external handwheel see chapter 1.4.3 page 24.. The level of handwheel signals is TTL as mentioned in the previous chapter.

Signals of axis and increment selection switches are connected to the keyboard matrix through column selection outputs O06, O07 and inputs I00, ..., I07. The level of O outputs and I inputs is TTL. The above signals encode 2*8=16 switch states, that can be tested by the PLC program through flags I450, ..., I457, I460, ..., I467.

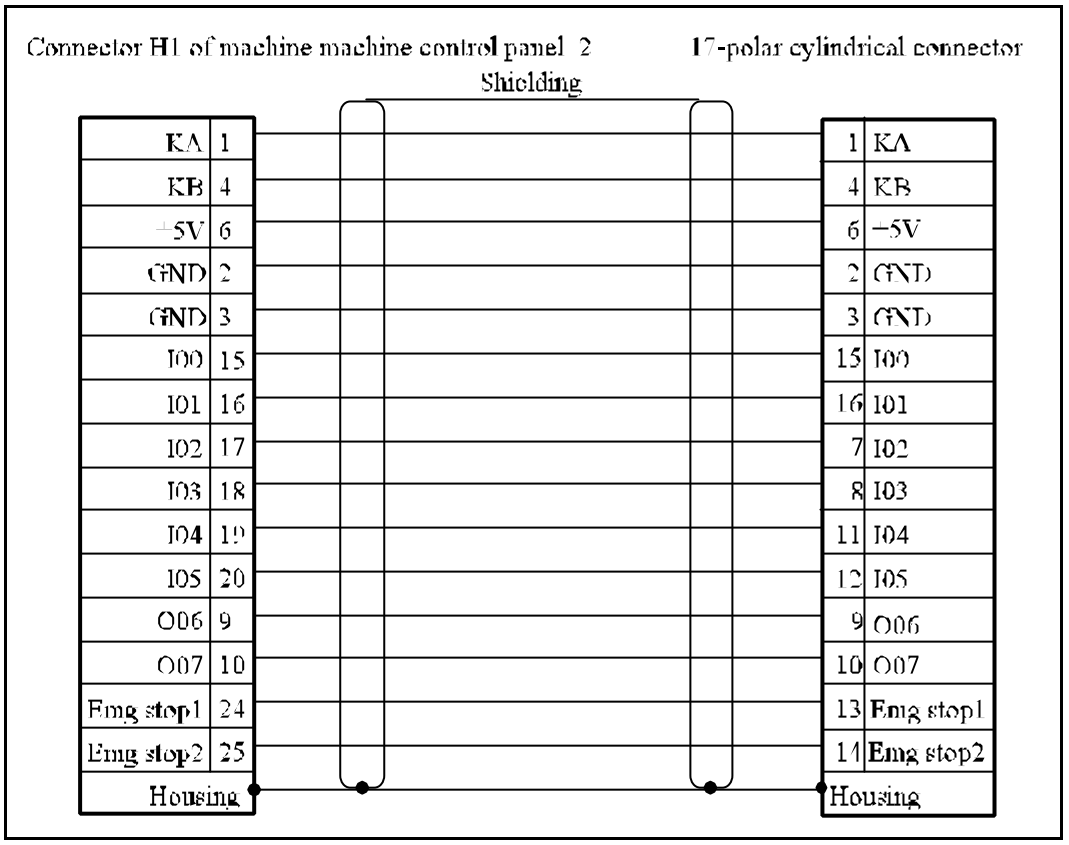


Pin assignment of external handwheel connector mounted on front panel

Only 24VDC voltage must be connected to the emergency stop button of external handwheel (wiring strip W1 on machine control panel 2) because of the isulation ratings of spiral cable delivered for external handwheel and of the nearness of TTL-level signals!

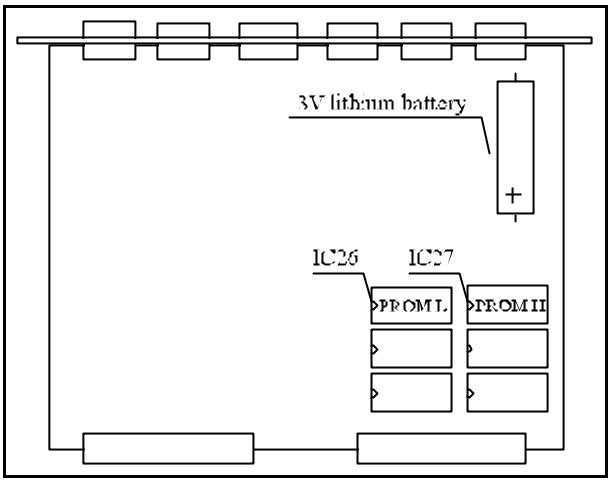
The external handwheel signals are connected to a 17 contact cylindric connector (plug). The

counterpart of connector (socket) is mounted to a suitable place by the machine tool builder *max. 500mm* far from machine control panel 2. The 17 contact cylindric socket must be cabled with handwheel connector H1 25 contact Dsub female on the machine control panel.



Linking external handwheel with machine control panel 2

2.7 CPU (Central Processing Unit) Board



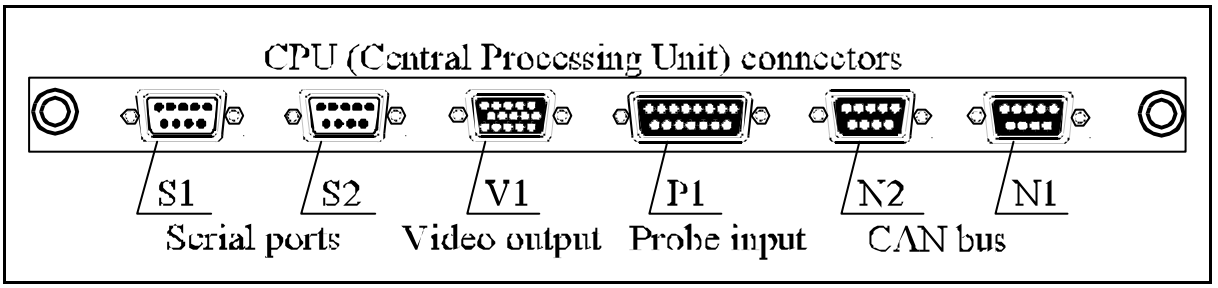
Apart from the central unit the CPU board is made up of:

- PROMs containing the control operating software,
- 3V lithium battery backing up CMOS RAMs for storing part programs even in case of power off,
- video control circuits,
- serial (RS-232C level) ports,
- inputs receiving signals of probe(s),
- as well as CAN bus control circuits.

Only 1 CPU board can be plugged into the logic unit.

For software updating, ICs with reference designations IC26 (PROM L) and IC27 (PROM H) being in socket must be changed.

☞*Warning!* *After pulling out from RACK the board must always be placed to an electrically insulated antistatic surface in order to promote CMOS parts and the contents of CMOS RAMs.*



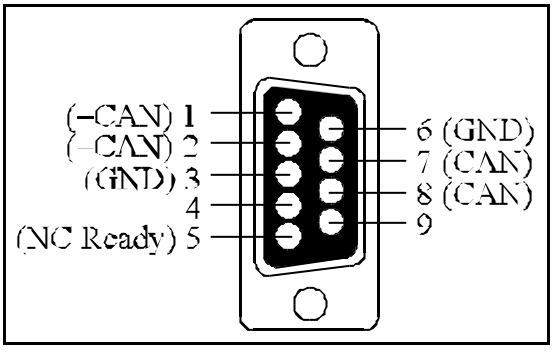
2.7.1 Pin Assignment of CAN Connectors (N1, N2)

Only units delivered for the control, as for example the operator's panel can be connected with the logic unit through connectors N1, N2 CAN (Control Area Network).

Connectors N1, N2 are *9 contact Dsub female*.

The structure and plugging topology of NCT CAN bus is discussed in chapter 2.2 on page 30.

The alphanumeric keyboard must always be connected to the CAN bus of connector N1.



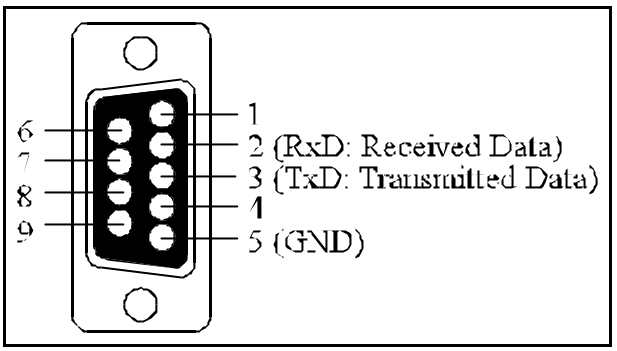
Pin assignment connectors N1, N2

2.7.2 Pin Assignment of RS-232C Serial Port Connectors (S1, S2)

Two serial channels are built on the CPU board. S1 and S2 are *9 contact Dsub male* connectors.

Signal levels

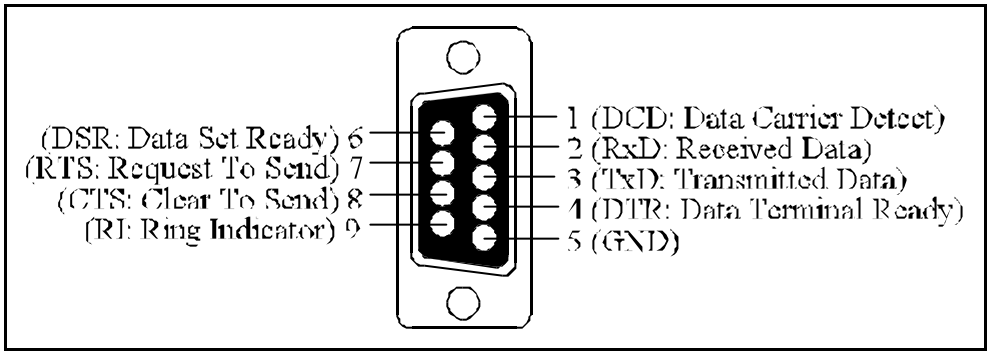
The I/O signal level is of RS-232C standard, i.e. **+/–12V**.



Pin assignment of connector S1

Port No. 1 (connector **S1**) is exclusively **for service purpose**. *Nothing should be plugged into this connector*.

Port No. 2 (connector **S2**) enables contact for **user purpose**. Part programs, as well as parameters and PLC programs can be uploaded and downloaded through this channel.

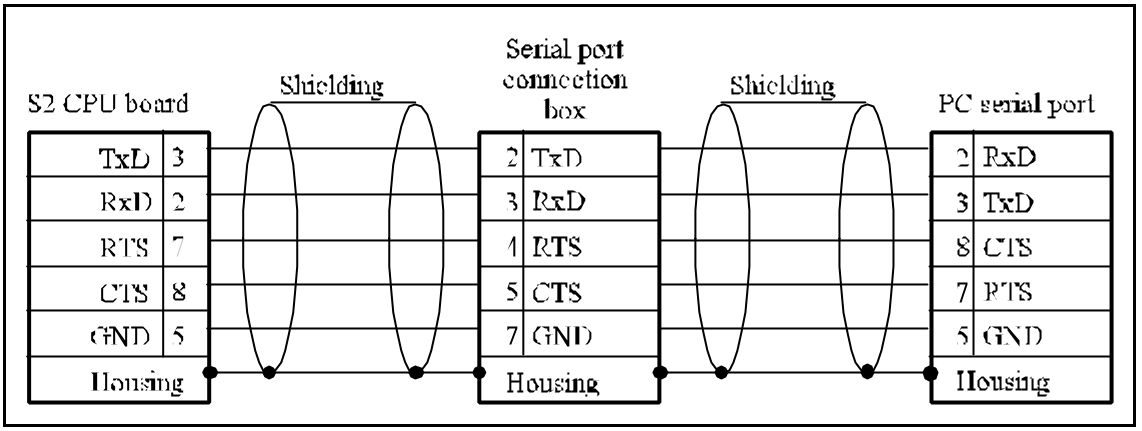

(DSR: Data Set Ready) 6
(RTS: Request To Send) 7
(CTS: Clear To Send) 8
(RI: Ring Indicator) 9
1 (DCD: Data Carrier Detect)
2 (RxD: Received Data)
3 (TxD: Transmitted Data)
4 (DTR: Data Terminal Ready)
5 (GND)

Pin assignment of connector S2

Parameters setting channel No.2 on connector S2 are as follows:

2002 BAUD RATE2
2022 WORD LENGTH2
2042 STOP BIT2
2062 PRTY CHECK2
2082 EVEN PRTY2
2102 EIA2
2123 CR2
2124 SPACE2

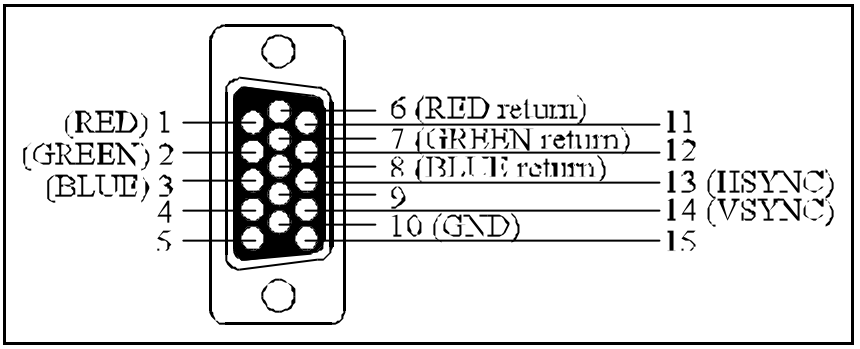
Serial port S2 of CPU board can be bound with the optional serial port connection box, which can be mounted on the front panel. (See chapter 1.4.5 page 25.).
Of the serial port signals it is enough to plug those seen on diagram.



Linking connector S2 of CPU board with serial port connection box and a PC

2.7.3 Pin Assignment of Video Output Connector (V1)

The video output can be used for driving standard VGA monitors.
The binding of monitor with connector V1 of CPU board is discussed in chapters 2.3 and 2.4 on pages 31 and 32.
Connector V1 *is 15p DHsub female*.



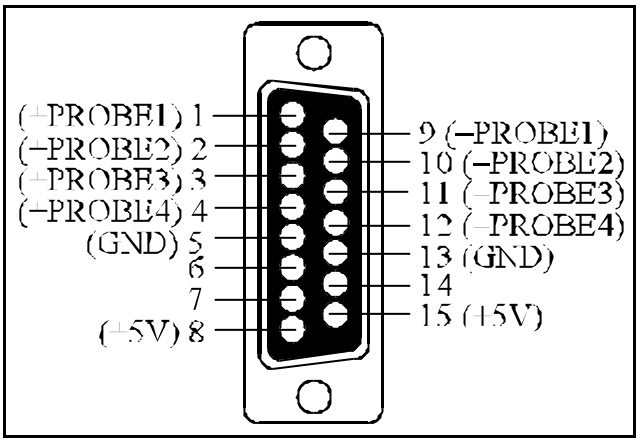
Pin assignment of connector V1

2.7.4 Pin Assignment of Probe Connector (P1)

The CPU board is capable of receiving the signals of 4 probes. Connector P1 *is 15 contact Dsub female*.

Signal levels

It is practical to apply interface board for receiving probe signals, since the CPU board receives **TTL-level** (5V) signals by means of line receiver, therefore the PROBEn and –PROBEn output signals of probe interface board may also be connected for the better noise immunity.



Pin assignment of connector P1

2.7.5 Configuring Probe Inputs

Probe inputs are needed in case of the execution of the following commands:
G31: skip function,
G36, G37: automatic tool length offset measure (G36 only on lathe control),
automatic tool length offset measure on lathe control.
Parameters *8041 G31BIT* and *8042 G37BIT* determine, which input belongs to which command.

For setting command G31 parameter *8041 G31BIT* must be set as:

8041 G31BIT	signal name	pins of connector P1
0	PROBE1, –PROBE1	1, 9
1	PROBE2, –PROBE2	2, 10
2	PROBE3, –PROBE3	3, 11
3	PROBE4, –PROBE4	4, 12

That is, if the signal of probe used for command G31 is connected to the 1st, 9th inputs of connector P1, parameter G31BIT No. 8041 must be set to 0.

For command G31... P
If G31 command is used with address P together value of address P defines the appropriate skip signal input:

G31... P	signal name	pins of connector P1
P1	PROBE1, –PROBE1	1, 9
P2	PROBE2, –PROBE2	2, 10
P3	PROBE3, –PROBE3	3, 11
P4	PROBE4, –PROBE4	4, 12

That is, if command G31... P2 is written the signal connected to the 2nd, 10th inputs of connector P1, will be effective.

For setting command G37 parameter *8042 G37BIT* must be set as:

8042 G37BIT	signal name	pins of connector P1
0	PROBE1, –PROBE1	1, 9
1	PROBE2, –PROBE2	2, 10
2	PROBE3, –PROBE3	3, 11
3	PROBE4, –PROBE4	4, 12

That is, if the signal of probe used for command G37 is connected to the 2nd, 10th inputs of connector P1, parameter G37BIT No. 8042 must be set to 1.

For automatic length offset measure on lathe control:

It is also parameter *8042 G37BIT* applied for automatic tool length offset measure in case of lathe control, since the probe used for this command is the same one used for commands G36, G37. Its setting corresponds to those above discussed.

2.8 XMU (Measuring System) Board and Its Options

The XMU board contains

circuits receiving signals of linear scales or rotary encoders, as well as
circuits generating analog signals to be sent to drives.

The XMU board is capable of receiving 4 encoder inputs and transmitting 4 analog outputs.
The encoder input is qualified for receiving TTL-level signals. Optionally it can be also built for receiving sinusoidal outputs, in this case the sinusoidal signal is quintupled (5*interpolated) and transformed to TTL pulses.
The board is mounted with 4 analog outputs giving the drive command signal. Optionally a TACHO board can also be attached to the XMU board, generating tacho signal from encoder pulses for the drives. This method can only be applied provided the rotary encoder is mounted to the motor axis, it cannot be used in case of linear scales.
In total 3 XMU boards can be built in the control.
The control is capable of operating maximum 8 position controlled axes, 1 spindle and 2 analog outputs.
Position controlled axes may be:

– NC axes. NC axes are those called from part program at specified addresses (X, Y, ...C). In the course of parameter specification the **physical axis** (reference with number: 1, 2, ...8) and the **logic axis** (reference with letter X, Y, Z, ...) to which the physical axis is to be referred to must be selected in AXIS parameter group. The physical axis selection determines e.g. the board and encoder input number of axis X from which the encoder pulse necessary for path measure is taken, as well as the board and pin number of command signal connector from which the command signal is sent to drive X.
– PLC axes. No direct reference can be made from part program to PLC axes. They receive movement command in the course of command execution through the PLC program. PLC signals such control of the appropriate axis by means of setting flags Y630, ..., Y637 to 1. The flags are always to be handled according to the physical axis number.

The control is only capable of operating axes of the first two XMU boards.
The spindle needing encoder inputs and command signal outputs can be configured to all three boards even if it needs orientation and positioning.
The free-purpose analog output can also be built in all three boards.

The encoder inputs can be applied for:

Path measuring inputs of position controlled axes. This can be adjusted by means of setting parameters *446n NOLOOPn* to 0. In this case the control sends analog command signal to the drive through the analog output belonging to the path measure input (when parameter 486n *DIGITALn* is 0), while when *486n DIGITALn* parameter is 1 it transmits digital command signal through CAN bus after evaluating encoder data.

Path measure inputs of non-position-controlled axes. This can be requested by means of setting parameters *446n NOLOOPn* to 1. In this case the encoder signals are only used for path measure, no command signal transmission is executed in the analog output belonging to the encoder input. The position of the appropriate axis can be read on the display.

Receiving rotary encoder signals mounted on the spindle. Parameter *5025 IOSELS1* determines the encoder input to be used for the spindle.

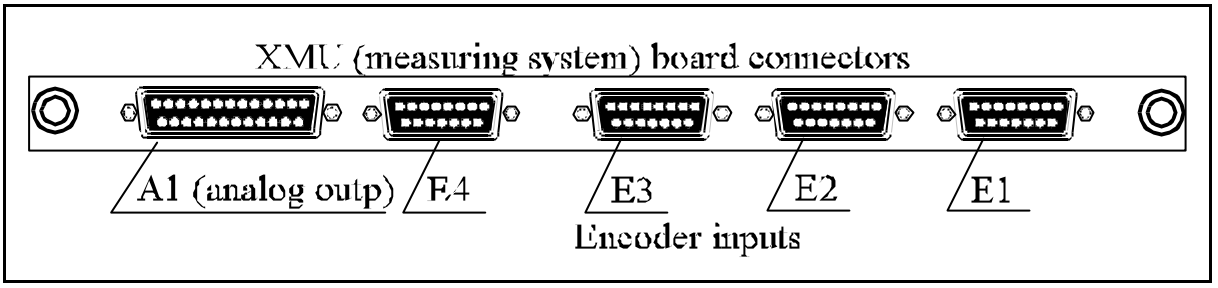
Analog outputs can be applied for:

Command signal output of position controlled axes. This can be adjusted by means of setting parameters *446n NOLOOPn* and *486n DIGITALn* to 0. In this case the control calculates command signal from encoder input signals belonging to the analog output and sends analog command signal to the drive.

Spindle speed command signal outputs. The output defined by parameter *5025 IOSELS1* is used for spindle speed command signal output when parameter *4869 DIGITALS1* is 0 .

Free purpose analog outputs. Analog outputs defined by parameter *010n COMMANDn*, that can be programmed through PLC registers, can be used optionally.

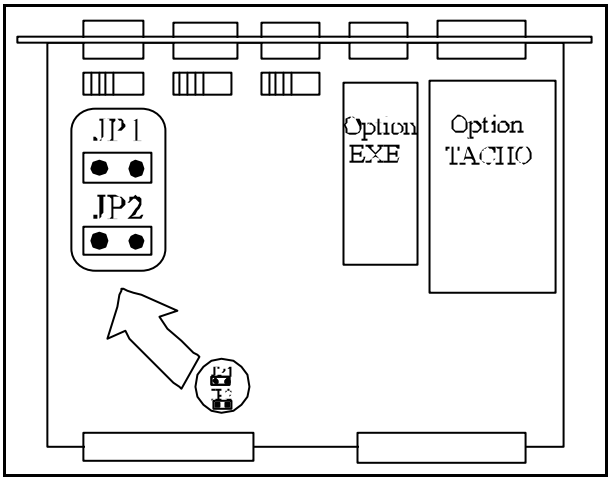
Tacho output (velocity feedback) in case of XMU board mounted with TACHO option board.



2.8.1 Configuring XMU Measuring System Board

Maximum 3 XMU boards can be built in the control. The hardware can be configured with jumpers JP1, JP2 found on the board in the following ways:

board number	JP1	JP2
XMU – 1	open	open
XMU – 2	closed	open
XMU – 3	closed	closed



TACHO option can be built in all boards as well as EXE interpolation and digitizing electronics can be built in all boards for each axis to receive sinusoidal output linear scales.

The XMU board connector and parameter state belonging to the appropriate physical axis number can be seen in the below table.

When setting parameters be sure to define only 1 command to 1 physical I/O. E.g.: if the 4th I/O of board XMU-1 is selected for both axis (4286 W=1, 4444 AXIST4=1 and 4464 NOLOOP4 =0) and spindle (5025 IOSELS1=4), it causes command signal transfer error without message.
The control is only capable of handling axes of the first two XMU boards.

physical axis number	board number	encoder connector	analog outputs	application possibilities	parameter
1	XMU–1	E1	A1/3,4,5	axis	**AXIST1=1**
				spindle	**IOSELSn=1**; **AXISTSn=1**
				analog output	**COMMANDn=1**
2	XMU–1	E2	A1/18,19,20	axis	**AXIST2=1**
				spindle	**IOSELSn=2; AXISTSn=1**
				analog output	**COMMANDn=2**
3	XMU–1	E3	A1/12,11,10	axis	**AXIST3=1**
				spindle	**IOSELSn=3**; **AXISTSn=1**
				analog output	**COMMANDn=3**
4	XMU–1	E4	A1/24,23,25	axis	**AXIST4=1**
				spindle	**IOSELSn=4**; **AXISTSn=1**
				analog output	**COMMANDn=4**
5	XMU–2	E1	A1/3,4,5	axis	**AXIST5=1**
				spindle	**IOSELSn=5; AXISTSn=1**
				analog output	**COMMANDn=5**
6	XMU–2	E2	A1/18,19,20	axis	**AXIST6=1**
				spindle	**IOSELSn=6**; **AXISTSn=1**
				analog output	**COMMANDn=6**
7	XMU–2	E3	A1/12,11,10	axis	**AXIST7=1**
				spindle	**IOSELSn=7; AXISTSn=1**
				analog output	**COMMANDn=7**
8	XMU–2	E4	A1/24,23,25	axis	**AXIST8=1**
				spindle	**IOSELSn=8; AXISTSn=1**
				analog output	**COMMANDn=8**
9	XMU–3	E1	A1/3,4,5	spindle	**IOSELSn=9**; **AXISTSn=1**
				analog output	**COMMANDn=9**
10	XMU–3	E2	A1/18,19,20	spindle	**IOSELSn=10; AXISTSn=1**
				analog output	**COMMANDn=10**
11	XMU–3	E3	A1/12,11,10	spindle	**IOSELSn=11; AXISTSn=1**
				analog output	**COMMANDn=11**

physical axis number	board number	encoder connector	analog outputs	application possibilities	parameter
12	XMU–3	E4	A1/24,23,25	spindle	**IOSELSn=12; AXISTSn=1**
				analog output	**COMMANDn=12**

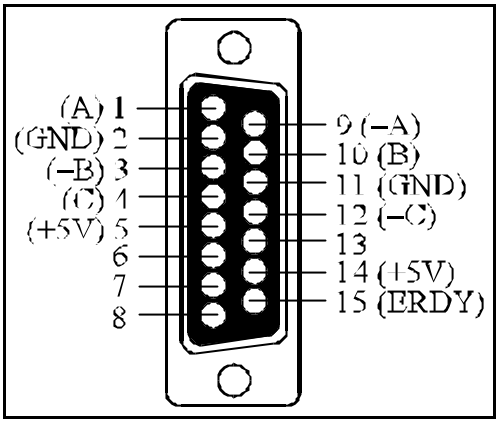
2.8.2 Pin Assignment of Encoder Connectors (E1, ..., E4)

The standard XMU board receives outputs of TTL encoders through line receivers. Connectors E1, ..., E4 are *15 contact Dsub female*.

The encoder connectors' layout (E1, ..., E4) are as seen on the enclosed diagram.

The input signals are automatically **quadrupled**, i.e. one is counted on rising and falling edges of phases A and B. Thus if the number of encoder pulses is 2500, the control counts 10000 pulses per encoder revolution.

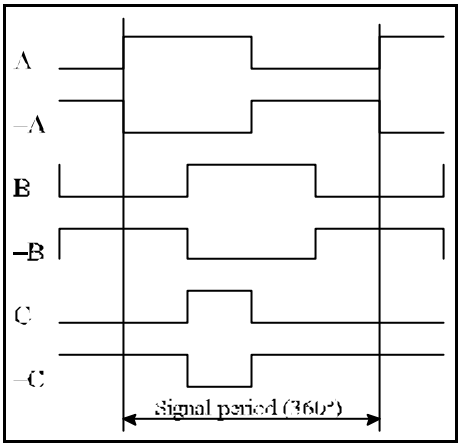
The encoder zero or reference pulse is received in input C, –C.



Pin assignment of connectors E1, ..., E4

Signal ***ERDY*** (Encoder ReaDY) is used only if external interpolation and digitizing electronics (not built in control) is applied, provided it is equipped with such an output. The level of signal ***ERDY*** is *TTL*. If this input is set to 0 (low) error message *002n ENCODERn* is sent by the control and switches MACHINE ON output of interface board off immediately, causing emergency state.

Likewise this error message is displayed in case of receiving TTL output, if the level of A, B, C, signals corresponds to that of –A, –B, –C signals in any phase (A, B or C). E.g.: both are 1 (high).



Form of TTL-output encoder signals

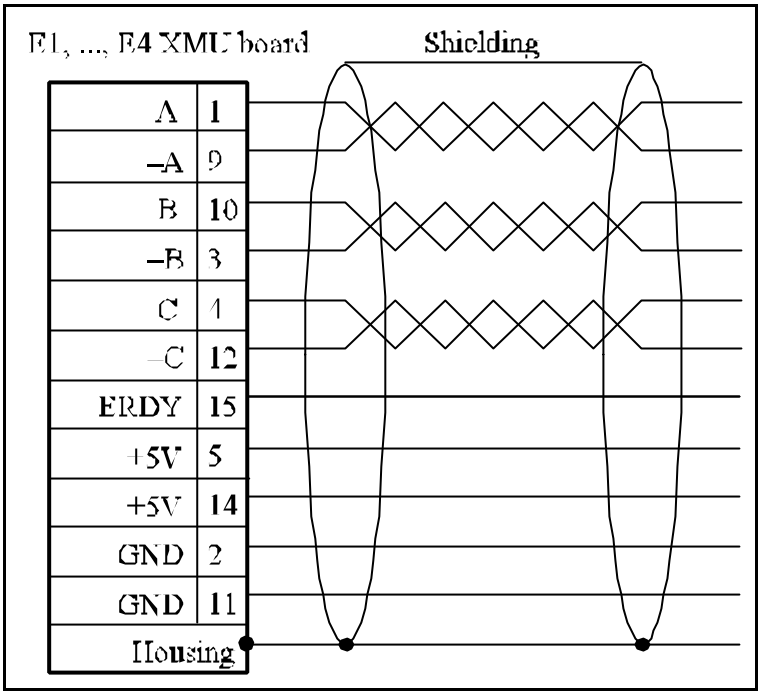
Input specification

maximum input frequency: $F_{in\ max}$= 500 kHz

input impedance between any signal input +5V: R_{in}=2.2 kΩ

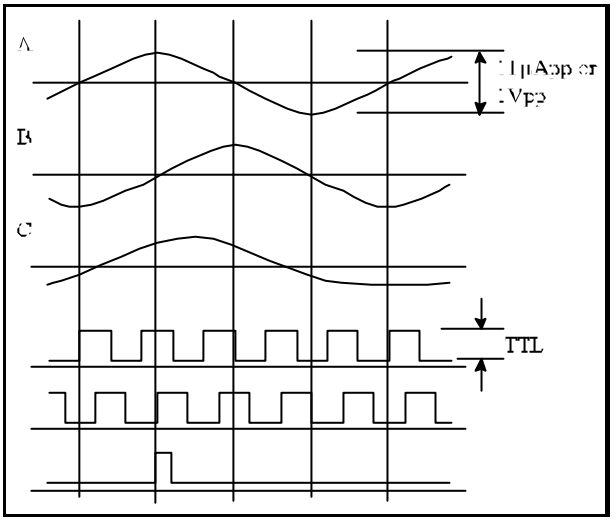
input impedance between signals and not signals: R_{in}=100 Ω, in serial C_{in}=100nF

Shielded, twisted pair cable must be used for encoder connection.



Connection of TTL-output encoders

2.8.3 EXEI or EXEV Option Board for Receiving Sinusoidal Encoder Outputs



Form of sinusoidal-output encoder signals

By building in an option board for each axis the XMU board is capable of receiving sinusoidal encoder outputs.

Two types of sinusoidal outputs may be received:

- Current signal **11µA$_{pp}$** is received by EXEI option board, while
- voltage signal **1V$_{pp}$** is received by EXEV option board.

The sine wave sent by the encoder is interpolated and digitized by EXEI or EXEV option board into 5 pulses and generates a TTL-level A–B signal to each part offset 90 deg among each other. Further on this pulse series is processed by the control as discussed in case of TTL inputs.

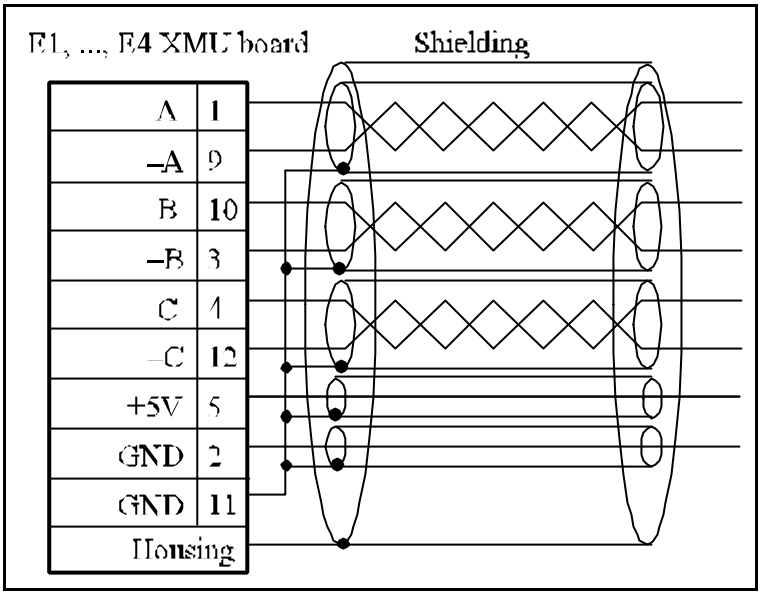
Thus if the linear scale (that is the sine period) is 20µm the internal EXEI or EXEV circuit generates 20µm/5=4µm-period TTL pulse series, which is evaluated by the control in the course of process four times and this results in 1µm measuring resolution.

The encoder connector pin assignment corresponds to that in case of receiving TTL signals.

In case of receiving sinusoidal signals, provided the level of signals (current or voltage) is inadequate error message *002n ENCODERn* is sent by the control and switches MACHINE ON output of interface board off immediately, causing emergency state.

Maximum input frequency: $F_{in\ max}$=25kHz

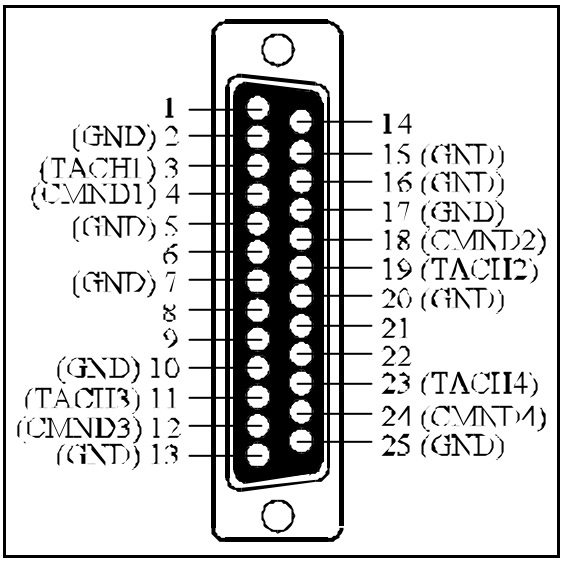
Cable with twisted pair wires, of which both the twisted pair wires and the whole cable are shielded and the supply voltage ***wires are shielded separately*** must be used for sinusoidal encoder connection!



Connection of sinusoidal-output encoders

2.8.4 Pin Assignment of Analog Output Connector (A1)

The velocity control loop command signal can be transmitted to the drives by means of connector A1:
CMND1, ..., CMND4
The command signals are generated from the signals with corresponding indexes coming from the encoder connectors. E.g.. command signal output CMND2 belongs to encoder connector E2.
Output ratings:
$U_{out\ max}$= +/–10V
$I_{out\ max}$= +/– 5mA
Connector A1 is *25 contact Dsub female*.



Pin assignment of connector A1

2.8.5 TACHO Option Board for Generating Tacho Output

In case optional TACHO (tacho-signal-generating) PCB is applied, the tacho signal is also transmitted through connector A1:
TACH1, ..., TACH4
Tacho signals are generated from signals with corresponding indexes coming from encoder connector. E.g. tacho signal output TACH2 belongs to encoder connector E2:.
The TACHO option board can only be applied if the encoder is mounted directly to the motor

axis.

Output ratings:

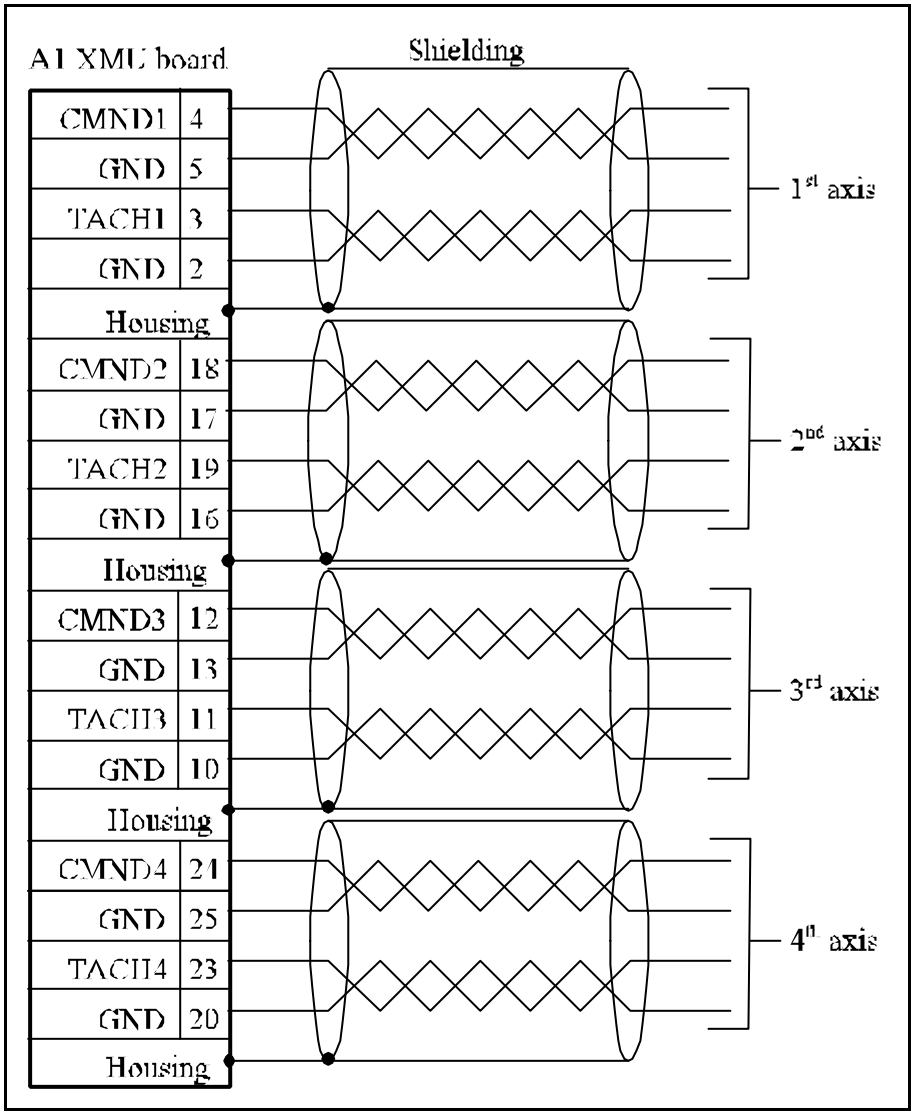
$U_{out\ max}$= +/–10V

$I_{out\ max}$= +/– 5mA

TACHO option board setting:

3V/33kHz, where the frequency is of pulses coming from encoder TTL.

☞ *Warning!* *Analog signals must always be transferred in shielded cables, far from motor wires and other high-voltage and high-frequency cables. AC servo motor cables must be shielded!*



Connecting analog outputs

2.9 INT (Interface) Board

INT board contains
- drivers of 24VDC-level two-state outputs and
- receivers of 24V-DC-level two-state inputs.

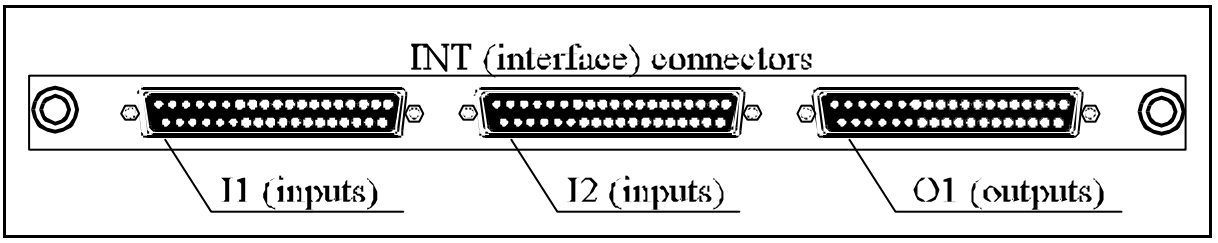
32 outputs plus MACHINE ON output can be found on the interface board. The board is built for receiving 48 inputs.
Maximum 4 INT boards can be built in the control. Therefore
- max. 128 outputs and
- max. 192 inputs

can be implemented.

INT board supply

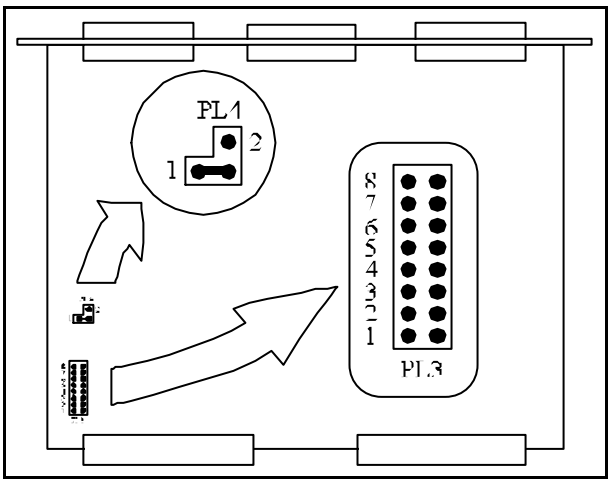
The user of control must take care of interface board supply:
- $U_{nominal}$: 24VDC
- U_{max}: 35VDC
- U_{min}: 20VDC

The supply does not require regulated voltage. Expediently 18VAC voltage must be rectified and filtered with a capacitor according to the load. See chapter 2.1.3 on page 29.



2.9.1 Configuring INT Board

INT board can be configured with jumpers PL3 and PL4.
Jumper PL4 must always be connected as stated on the diagram.
In jumper group PL3 those with signals 3, 4, 5, 6 can be used. For INT board No. 1 use jumper position No. 3, for INT board No. 2 use jumper position No. 4, etc.
MACHINE ON output must always be connected to just one board, suitably to the first one.



2.9.2 Pin Assignment of Connector of 24V Outputs (O1)

The interface outputs can be found on connector O1. Connector O1 is *37 contact Dsub female*.
The outputs are marked as referred to in PLC program. Letter n in place of the first digit after character Y is indexed according to the INT board number:

n=0 refers to outputs on 1st board,
n=1 refers to outputs on 2nd board,
n=2 refers to outputs on 3rd board,
n=3 refers to outputs on 4th board.

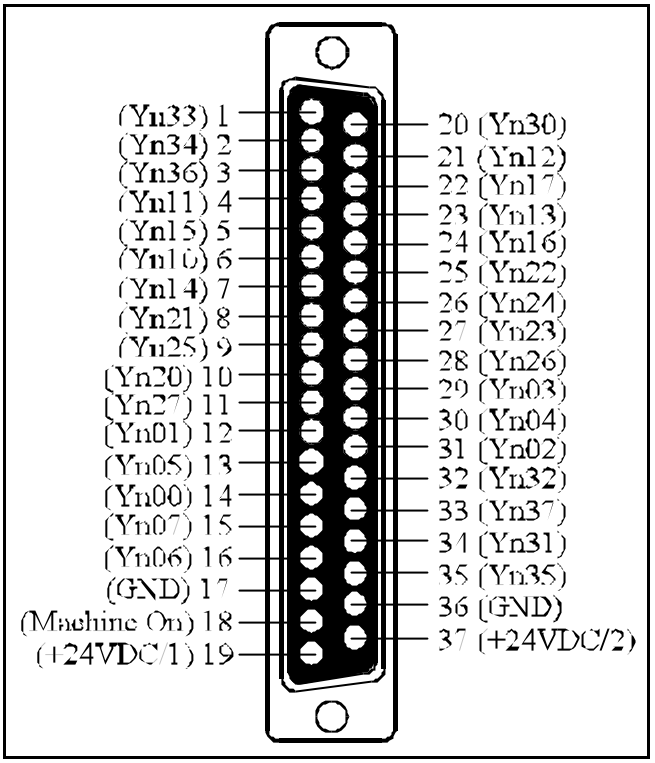
The MACHINE ON output switched on from PLC program with reference U540 can be found on this connector. The condition of switch-on is that

the NC is ready and
there is no emergency state (e.g.: servo loop error).

Current ratings of outputs:

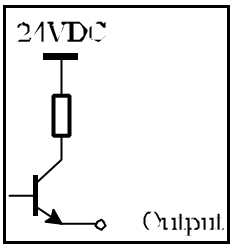
$I_{out\ max}$=200mA

The outputs give out 24V in switched-on state.



Pin assignment of connector O1

The outputs are short-circuit-proof and overload-proof. If one of INT boards is short-circuited error message *SHORT CIRCUIT ijk* is sent by the control, where: i=0 refers to the 1st, i=1 to the 2nd, i=2 to the 3rd and i=3 to the 4th interface board,
as well as j=0 to the first, j=2 to the second 16 output groups on the appropriate board.
Further details of the short-circuited output are not given, value k is always 0.
This error creates EMERGENCY state, i.e. MACHINE ON output is switched off.



<u>There are two power supply inputs in connector O1: +24VDC/1 and +24VDC/2.</u>
In case of control types ***NCT99 and NCT990 the two inputs are shorted***.
In case of control types ***NCT100 and NCT2000 the two inputs are separeted***. The

input **+24VDC/1** supplies the outputs **Yn00, ..., Yn07, Yn10, ..., Yn17**, while the
input **+24VDC/2** supplies the outputs **Yn20, ..., Yn27, Yn30, ..., Yn37**.

2.9.3 Pin Assignment of Connectors of 24V Inputs (I1, I2)

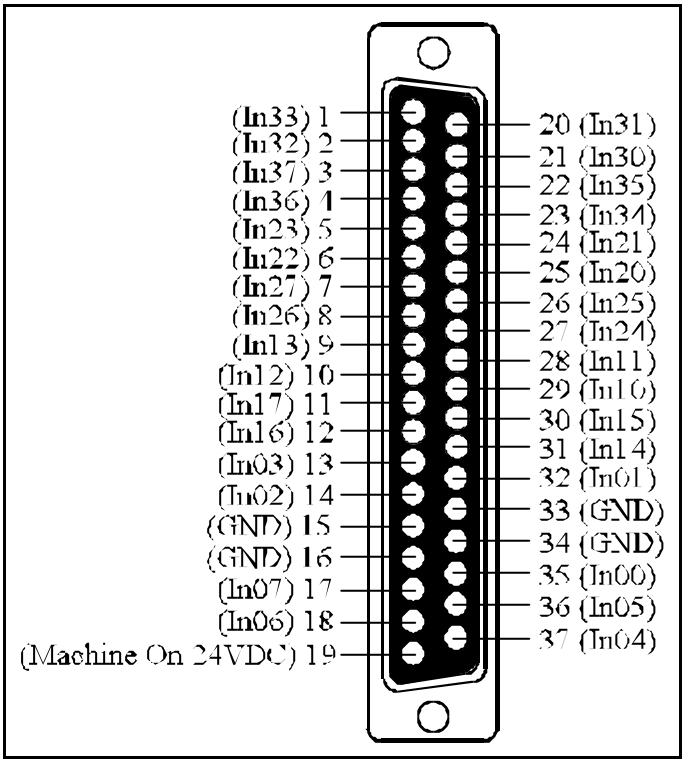
The interface inputs can be found on connectors I1, I2. Connectors I1, I2 are *37 contact Dsub female*. The inputs are defined as referred to in PLC program. Letter n in place of the first digit after character I is indexed according to the INT board number:

n=0 refers to input on 1st board,
n=1 refers to input on 2nd board,
n=2 refers to input on 3rd board,
n=3 refers to input on 4th board.

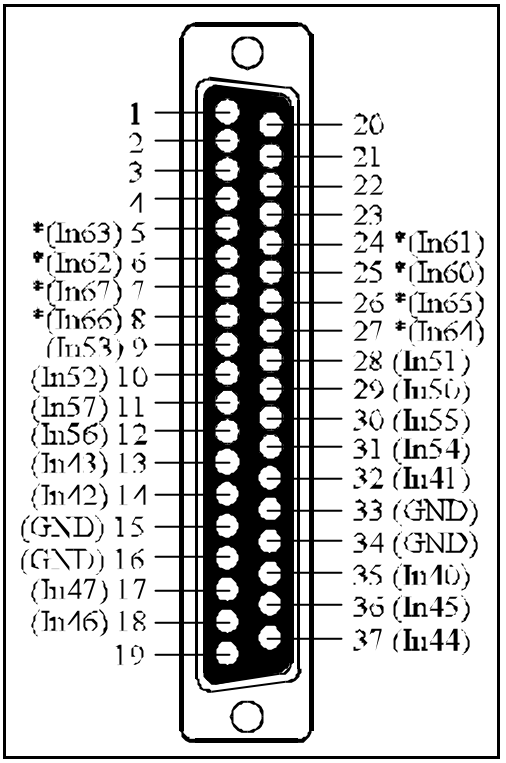
Signal *Machine On 24VDC* from which the MACHINE ON output on pin 18 of connector O1 can be exclusively supplied is found on connector I1. In the course of power-on provided the NC is ready and there is no emergency state, MACHINE ON signal can switch the 24V on for the other interface inputs.

Current sink ratings of inputs powered by 24V:

I_{in}=10mA



Pin assignment of connector I1



Pin assignment of connector I2

*The inputs marked with * are built in only in controls NCT100 and NCT2000*

2.9.4 Connecting INT Board and Machine Magnetics

The following principles must be followed when connecting INT board. (See diagram below.) The circuit drafted below is the simple version of emergency circuit and serves only for illustration how to connect the machine and control.

After powering the machine and control 24V must be instantly switdhed to input Machine ON 24VDC (pin 19 of connector I1). The supply voltage is only switdhed to input +24VDC (pins 19, 37 of

connector O1) through contacts 3, 4 of relays K1 and K2 after the machine is successfully turned on.

Advised power-on process

– press Machine On button mounted on machine control panel 2 or on other place of the machine,
– in case **neither** slide **is on emergency limit position** and all **emergency stop buttons** are closed, 24V is switched to input **machine on button pressed** (I002) (naturally any input can be used in place of I002).
– afterwards the PLC program of control **switches Machine On** output **on** (pin 18 of connector O1), activating relay K3 and relay K1 receives supply through contacts 1, 2 of relay K3.
– relay K2 is switched through contacts 1, 2 of relay K1 and **relays K1 and K2** are **latched** through contacts 1, 2 of relay K2, the circuit is closed even after machine on button is released,
– INT board receives **supply voltage** through contacts 3,4 of relays K1 and K2.

According to the diagram emergency stop is caused by emergency limit switches and emergency stop buttons.
Emergency state can also occur as an effect of NC if it switches Machine On output off. This latter case is given rise to,

– if PLC switches flag Y540 off,
– if NC registers fatal error (servo, feedback, encoder error, short circuit on INT board)
– if NC watchdog timer drops out (NC Ready signal ceases).

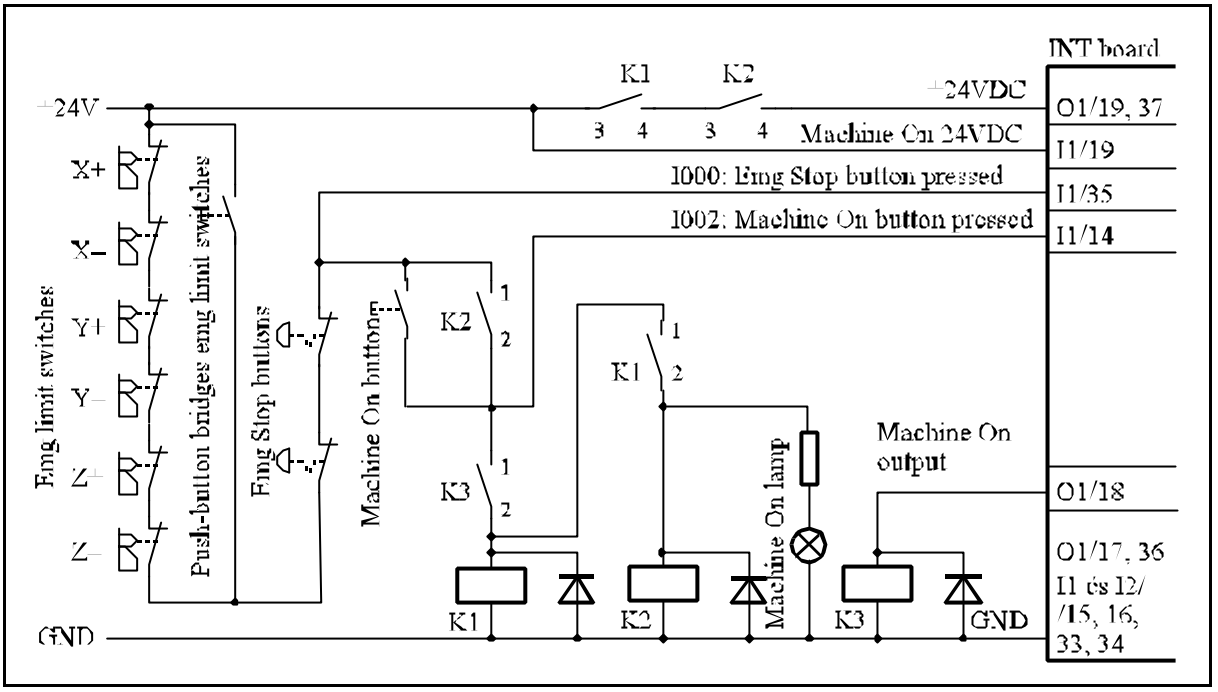
In the course of emergency stop provided the slides run to emergency limit end position or emergency stop button is pressed the stop process is as follows:

– NC is informed of the event through input **emergency stop button pressed** (I000) and **switches Machine On** output **off**,
– relays **K1, K2 drop out**, the **latched state ceases** and **INT board supply is interrupted** through connectors 3,4 of relays K1, K2.

In case emergency stop is sent from the NC side, for example NC Ready signal ceases:

– **Machine On** signal is **switched off** and relay **K3 drops out.**
– **latched state** of relays **K1** and **K2** is **interrupted** through contacts 1,2 of relay K3,
– **INT** board **supply** ceases through contacts 3, 4 of relays K1 and K2.

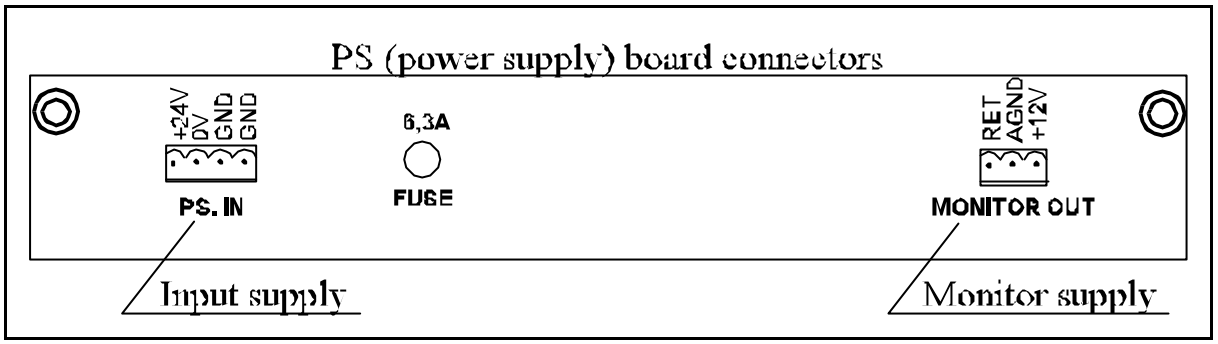
PLC-program-side techniques can also be looked through in the manual of Integrated PLC of NCT 98, 99 Machine Tool Controls.



Connecting INT board and machine magnetics

2.10 PS (Power Supply) Board

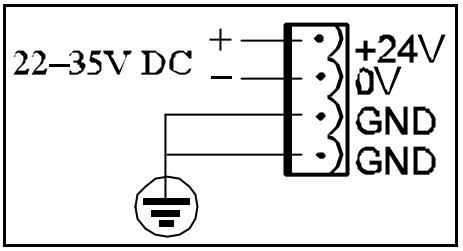
The PS board provides the supply for the logic unit as well as transmits regulated 12V DC to monitor supply in case monochrome monitor is applied on the operator's panel. A screw-jointed counterpart - control accessory - belongs to male connectors PS.IN and MONITOR OUT.



2.10.1 Pin Assignment of Connector PS.IN (Power Supply Input)

Supply voltage rectified and buffered from 24V alternating current must be connected to power supply input PS.IN. Rectifying is executed by means of control accessory NCT ACDC unit.

Input voltage must always be connected *between inputs +24V and 0V* and **not** between +24V and GND, otherwise the current measuring resistance between power supply inputs 0V and GND is short-circuited, which may result in demage of control.

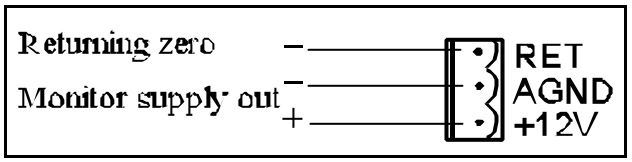


Pin assignment of power supply input connector (PS.IN)

Input GND must be connected to the earth ground of the machine magnetics. For details on supply connections see chapter 2.1.2 on page 28..

2.10.2 Pin Assignment of Connector MONITOR OUT (Monitor Supply)

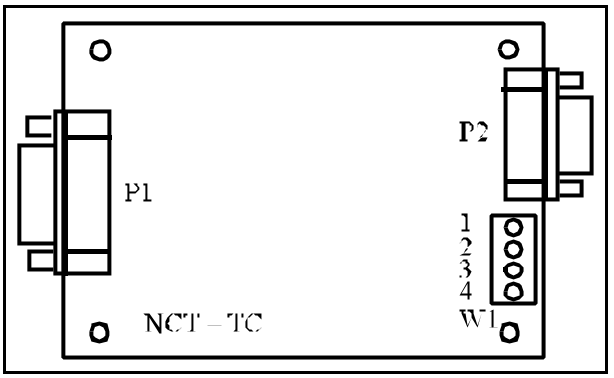
In case monochrome monitor is applied on the front panel it can be supplied from power supply connector MONITOR OUT. The returning zero output serves for the 12V regulator to measure supply voltage at the monitor. For details on monitor connection see chapter 2.4.1 on page 32.



Pin assignment of monitor supply connector (MONITOR OUT)

2.11 Connections of Probe Interface Unit NCT–TC

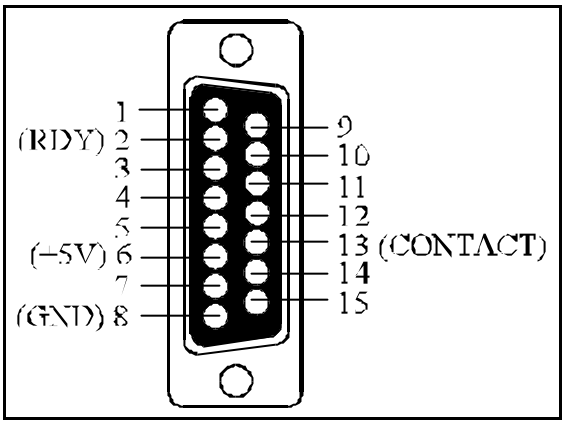
The interface electronics are connected to probe through connector P1. +5V supply is sent as well as the probe signals are received through P1. The probe functions as a switch, i.e. if the probe is not pressed the contact is closed, if however it is pressed the contact is open.
The interface unit generates pulse from probe signals by means of both pressing and release, which is transmitted to CPU board probe input through connector P2 (connector P1 of CPU board).



Connectors of probe interface unit NCT–TC

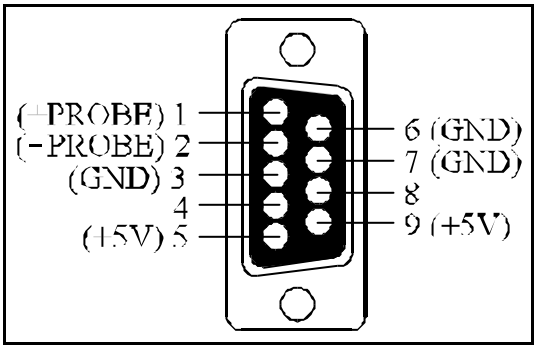
Apart from this the probe signals are transformed to +24V interface signals, that can be reached on wiring strip W1.

Signals found in probe input connector P1:
– **+5V** and **GND**: supply voltage output for probe electronics,
– **RDY**: TTL-level probe ReaDY signal, input,
– **CONTACT**: TTL-level probe signal, input.



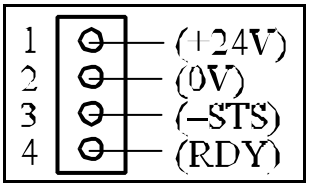
Pin assignment of probe input connector P1

Signals found in probe output connector P2:
– **+5V, GND**:supply voltage input for NCT–TC unit,
– **+PROBE, –PROBE**: bounce-free pulse signal generated from rising and falling edge of probe CONTACT signal. TTL-level signal driven by line driver, appr. 300-500 msec wide.



Pin assignment of output connector P2

Signals found on wiring strip W1:
– **+24V, 0V**: interface supply voltage input,
– **RDY**: 24V respective of probe ready signal. Output. It signals probe appearance when connected to control interface input. For

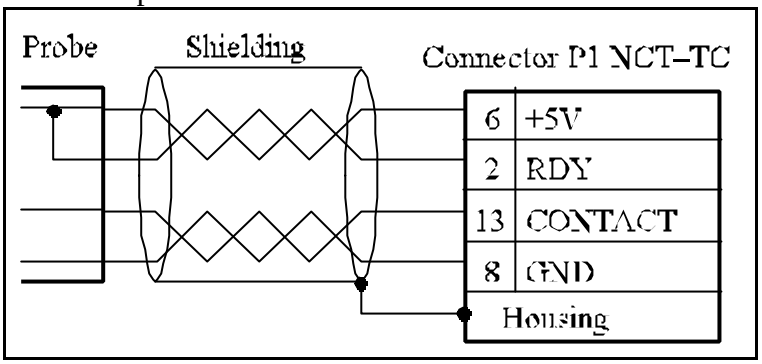


Pin assignment of wiring strip W1

example in milling machine in case the probe can be put in spindle, if this signal is 1, the spindle must not be rotated.

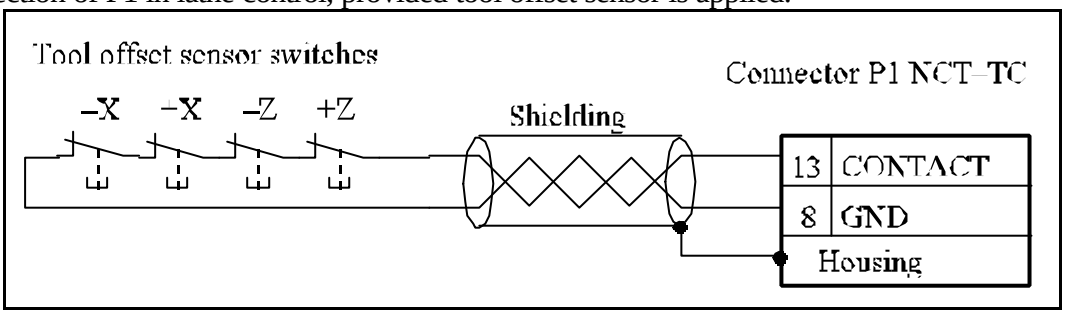
– –**STS**: probe status. 24V, bounce-free output. If the probe is pressed the output is 0, if not it is 1.

Probe input connector P1 must be connected in function of the selected probe. NCT–TC PCB must be placed to the probe signal source as near as possible. If no RDY (ready) signal is sent by the probe +5V must be wired back to input RDY.



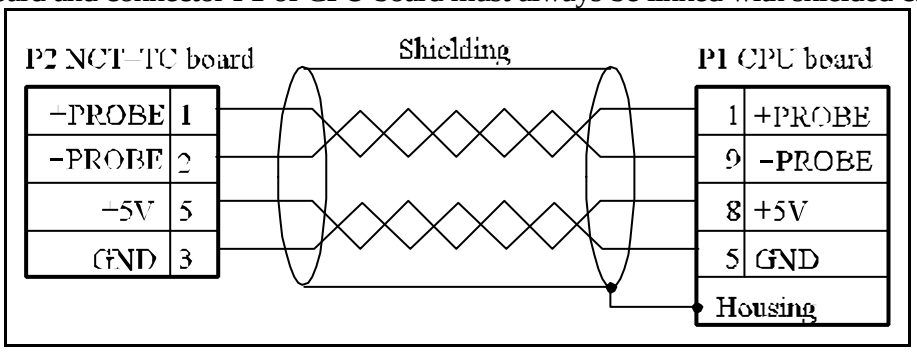
Connection of probe and NCT–TC P1

Connection of P1 in lathe control, provided tool offset sensor is applied:



Connection of tool offset sensor and NCT–TC P1 on lathe

NCT–TC board and connector P1 of CPU board must always be linked with shielded cable:



Connection of NCT–TC board and CPU board

Connection of wiring strip W1 in milling machine, provided NCT measuring macros are applied:

It is expedient to connect signals RDY and –STS in the following way, for not to overwrite subprogram

O9984:

–STS: Ipq0, i.e. connect it to input No. 0 of q^{th} byte of p^{th} INT board. (Eg.: I040, 4^{th} byte 1th board)

RDY: Ipq1, i.e. connect it to input No. 1 of q^{th} byte of p^{th} INT board. (Eg.: I041, 4^{th} byte 1th board)

+24V and 0V are interface supplies also used by INT board.

Connection of signals of wiring strip W1 in lathe control in case of automatic offset measure:

In case of automatic length offset measure PLC program only uses signal –STS. For example in the sample example discussed in chapter 4.10 on page 111. it is connected to input I027.

–STS: can be connected to any INT board input.

RDY: not used.

3 INSTALLATION AND SERVICE FUNCTIONS OF CONTROL

The control installation requires the installing expert's overall knowledge. This knowledge can be attained from the following manuals:

NCT99M (or T) Operator's Manual,
NCT99M (or T) Programmer's Manual,
NCT99 PLC Programmer's Manual

In this chapter only the materials not included in the above manuals - as no necessities of normal control functioning - are discussed.
First of all the power-on process of control, than the built-in functions needed for control installation, service, diagnostics are discussed. These can be divided into two grand groups:
– SERVICE UTILITIES mode functions acquired before total start-up of control,
– as well as service functions acquired in the course of normal control functioning.
Finally the built-in security functions are shown.

3.1 Power-on Process of Control

The control gains **codes** necessary for its operation, values of **parameters** influencing its functioning as well as **PLC program** interfacing it to the given machine from *DRAM* in the course of functioning. In power-off state the DRAM content is destroyed, thus in the course of power-on the DRAMs must be uploaded from *PROM*, *CMOS RAM* and *FLASH ROM*.
*PROM*s found on control CPU board are burned in while control production and contain the *codes* needed for control opration.
The CMOS RAM content is backed upon power-off with the help of *lithium battery* found on CPU board. *Part programs*, work *offsets*, *tool compensation values* and other *setting values* of control are stored in *CMOS RAM*.
The *FLASH ROM* content is also reserved upon power-off. The desired content *must be burned in* in FLASH, which takes a longer time. The *PLC program* and *parameters* are stored in FLASH.

3.1.1 First Cycle of Start-up Procedure

After power-on the control first executes self-diagnostics, checks the checksum of codes in PROMs and parameters stored in FLASH, afterwards it uploads to the DRAMs.
If error is found in one of the codes (SYSTEM, HGSZ, PLC), or in parameters the start-up procedure stops.
If error is found among the codes, PROMs containing codes on CPU board must probably be changed.
If error is found among parameters read the following chapter 3.1.2 on page 61..
If all functions are in perfect trim in the start-up process, the following screen appears on the monitor:

```
    NCT 33MHz CPU 12 Axes (c) NCT

       Ver.: 3.00 X_MU 00/02/25

Code test

     SYSTEM          -    OK!

     HGSZ            -    OK!

     PLC             -    OK!

RAM test:

     Parameters-     OK!
```

When the above screen occurs the SERVICE UTILITIES may be opened as discussed in chapter 3.2.1 on page 64.. If not, after a few seconds the control starts the second cycle of power-on process.

3.1.2 Parameter Storing. Message Parameters – Error.

The parameter values are moved from FLASH ROM to DRAM by the control in the course of power-on procedure.
In case the parameters are *edited* the *modified* parameter values are sent to *DRAM*. *The data in DRAM* are burned into FLASH in time of only *changing screen* (exit from parameter edit screen), with the escort of a checksum. The above process is signaled by the 1-2-second-gleam of caption **Burn** in the 4th status field.
In case parameters are *changed* from *PLC* program, these are moved directly to the *DRAM*. *Parameter change from PLC does not burn in data into FLASH* . The modified parameters could only be transmitted to FLASH ROM should the parameter edit screen be entered and exited. There is no need to burn in parameters into FLASH while changed by PLC, for the some parameter values are adjusted either in function of a condition after every power-on as a part of the initializing procedure (I511=1) or in function of an interface I/O state.
If the start-up is executed with message

Parameters – Error

this means, that the FLASH ROM checksum is damaged. If afterwards button (reset) is pressed the control loads content of parameters from FLASH ROM to DRAM and the start-up is executed in the usual way (provided it is possible with parameter set in FLASH). *After this however the control disables machine power-on*. With this either the parameters must be loaded through serial port or the store content must be checked by means of parameter edit.
If after all the control does not execute start-up in the usual manner after pressing reset key SERVICE UTILITIES mode must be opened and the basic parameter set stored in PROM must be downloaded.

3.1.3 Second Cycle of Start-up Procedure. Other Error Messages.

In case the parameters are also found in good trim by the control the second cycle of start-up procedure gets started. In the course of this the ABSOLUTE POSITION screen is set up. During the start-up the following checks are executed:

– The checksum of PLC program stored in FLASH is checked. If error is found the following message is displayed:

PLEASE LOAD A PLC PROGRAM

This message is also written in German and Hungarian in the message field. In this case two things can be done. It is either to select PLC screen of SERVICE screens and load the machine PLC program, or ,provided it is not ready, to activate SERVICE UTILITIES mode after restarting the control, where a basic PLC program can be downloaded from PROM.

– Data stored in CMOS RAM is checked. If error is found in one of them message is sent. The messages may be as follows:

3504 TOOL POT TABLE BAD,
3508 NC STATE TABLE BAD,
3509 TOOL LIFE TABLE BAD,
3510 TOOL OFFSET TABLE BAD,
3511 WORK OFFSET TABLE BAD,
3545 MACRO TABLE BAD

The above error messages can be deleted by means of button (reset). In this case the tables belonging to the message are cleared.

3.1.4 Changing the Softkey Number and Screen Color

The meanings of softkeys are written to the bottom edge of monitor. The softkey numbers drawn on monitor must correspond to that of softkeys mounted under the monitor (F1, F2, ...). The sofkeys are drawn on the screen by the control according to the value of parameter 1130 **SFNUMB**.
In the course of control installation, e.g. after loading a parameter set brought from an earlier installation the number of softkeys seen on screen may differ from the number of softkeys under the monitor.
If the number of softkeys on screen is less than the number of softkeys mounted under the monitor (e.g.: 5 on the screen, 10 under the monitor) the PARAMETERS screen of SERVICE group can be selected by the usual paging technique and the number of softkeys drawn on screen changes by the overwriting of parameter 1130 **SFNUMB**.
However this method is of no use if the number of softkeys on screen is larger than the number of softkeys under the monitor (e.g.: 10 on the screen, 5 under the monitor).
It can also occur that the screen color is set, or after parameter loading color is set, so that e.g. the parameters cannot be edited, because e.g. the cursor or the parameter name is not visible.
The procedure is as follows: select

ABSOLUTE screen of POSITION group (this screen is set up by the control after power-on) than press button

(action menu button). Afterwards enter the following text with the help of the alphanumeric keyboard:

S O F T K E Y Finally press

last softkey under the monitor.

If e.g. **5 softkeys** are mounted under the monitor press button F5,

if however **10 softkeys** are mounted press button F0.

Hereupon the number of softkeys drawn on control screen is changed and the control applies the default coloring as if **USERCOLOR** No. 0521=0 had been set.

☞ *Warning!* *As the effect of the above operation parameters 1130* ***SFNUMB*** *and 0521* ***USERCOLOR*** *are not overwritten, i.e. are set upon control power-off to the original softkey number!*

Select PARAMETERS screen, enter the appropriate value to parameter **SFNUMB** No. 1130 as well as set the right coloring.

3.1.5 Resetting Control without Power-off

The control can also be reset without power-off in the following way:
– press emergency stop button (in reality switch Machine on request flag Y540 off),
– press simultaneously the following buttons and keep them pressed:
(reset), (screen menu button) and (action menu button).
In this case the control starts the start-up from the first cycle of power-on procedure.

3.2 Functions of SERVICE UTILITIES

In the course of start-up procedure the functions of SERVICE UTILITIES can be started with a special button combination.

3.2.1 Activating SERVICE UTILITIES Mode

The screen seen in chapter 3.1.1 on page 60 is set after power-on and first cycle of start-up procedure. If no error occurs when checking codes, the control waits a few seconds, independent of the parameters being in good trim, or not.
If within this time buttons

(reset),

F1 (softkey No. 1),

F3 (softkey No. 2),

F5 (softkey No. 3),

are pressed in the above order SERVICE UTILITIES mode is activated. In this case the following captions appear on screen:

```
NCT 99 (c) SERVICE UTILITIES

  F1 - MEMORY TEST

  F2 - VIDEO + RS TEST

  F3 - KEYBOARD TEST

  F4 - INT & MU CARD TEST

  F5 - MEMORY MONITOR
```

Only F1 – MEMORY TEST function group has to be considered regarding control installation, the others can only be used for control test and checkout.

3.2.2 MEMORY TEST Functions

After SERVICE UTILITIES mode is activated as discussed in the previous chapter the MEMORY TEST functions can be selected by means of pressing button F1. When pressing the button the control offers the below alternatives on the screen:

F1 – RAM TEST: by pressing button F1 further subfunctions appear. Its description is discussed later on.

F2 – BOOT PARAMS: by pressing button F2 a standard parameter set is loaded from the PROM and the current parameters are overwritten. *The standard parameter set is set to 5 softkeys.*

F3 – BOOT PLC: by pressing button F3 a basic PLC program is loaded from the PROM and the active PLC program is overwritten.

SERVICE MEMORY

F1 - RAM TEST

F2 - BOOT PARAMS

F3 - BOOT PLC

F4 - START RTC

F5 - WARM RESTART

F4 – START RTC: by pressing button F4 the Real Time Clock is started by the control. (The clock is started in the control during final measurement.)

F5 – WARM RESTART: by pressing button F5 the control exits SERVICE UTILITIES mode, executes second cycle of start-up procedure and sets ABSOLUTE POSITION screen, like after a normal start-up.

The previous level can always be returned with the help of screen menu button . For example, if SERVICE MEMORY function is active on screen, by pressing button the NCT 99 (c) SERVICE UTILITIES screen is returned.

In case **F1 – RAM TEST** function is selected the following alternatives may be selected on screen:

F1 – DRAM TEST: by pressing button F1 the DRAM memory is checked functionally.

F2 – CMOS RAM TEST: by pressing button F2 the CMOS-RAM memory is checked functionally.

F3 – FLASH ROM TEST: by pressing button F3 the FLASH-ROM memory is checked functionally.

F4 – CMOS RAM CLEAR: by pressing button F4 the CMOS RAM is cleared. This function deletes all table and setting values.

F1 - DRAM TEST

F2 - CMOS RAM TEST

F3 - FLASH ROM TEST

F4 - CMOS RAM CLEAR

F5 - FLASH ROM CLEAR

F5 – FLASH ROM CLEAR: by pressing button F5 the FLASH is cleared. This function deletes parameters stored in FLASH and the PLC program.

By pressing screen menu button the previous SERVICE MEMORY level is returned.

3.3 Service Functions during Regular Control Functioning

The below description presumes control operating knowledge found in "Operator's Manual". This chapter is basically an appendix to the above manual, since control service functions are not discussed there.

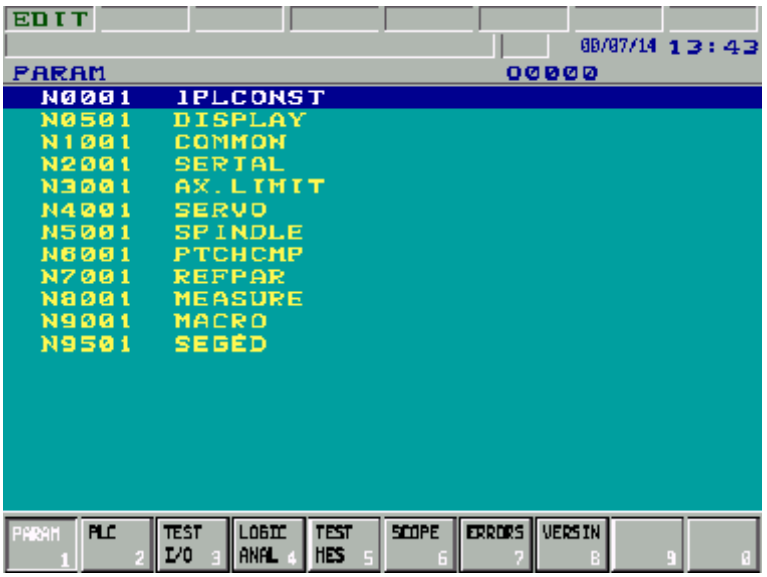
As a reminder: the display menu consists of two levels and the following groups can be found in the first level;

Oprtr's Panel 1	**Positn** 2	Check 3	Program 4	Offsts 5	Grphcs 6	Setting 7	Service 8	9	Page 0

The above state can be generated by the repeated pressing of screen menu button .

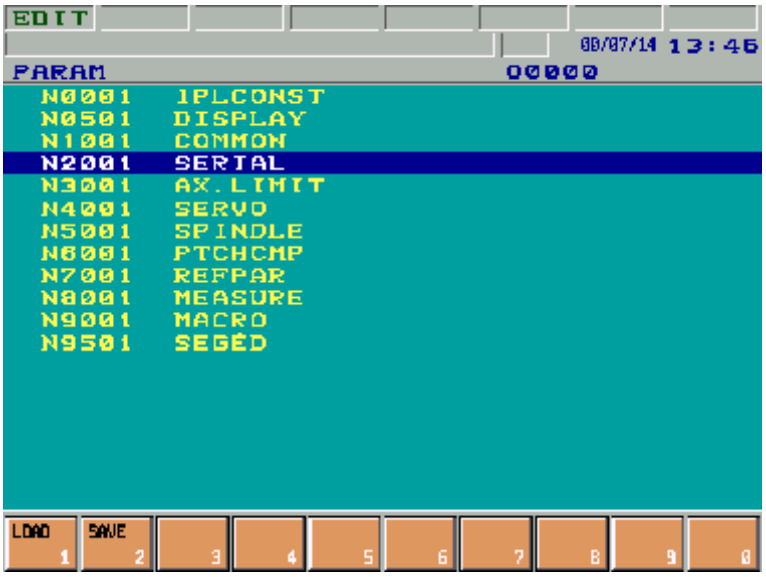
Select Service menu by pressing the softkey with corresponding caption. After entering the second level (by the repeated press of Service softkey) the service functions offered by the control can be activated with the help of the softkeys:

Params 1	PLC 2	I/O Test 3	Logic Anal 4	Test mes 5	Scope 6	Errors 7	Version 8	9	0



The desired function (screen) can be activated by the pressing of the appropriate softkey.
After power-on as opening service functions it is always the PARAMETERS screen offered first. In case another screen is selected (e.g. by pressing Scope) and than the Service screens are closed, (by means of screen menu button), and later on the service screens are re-opened with the help of Service softkey, then the screen selected previously (OSCILLOSCOPE) is displayed on monitor. In other words the monitor "remembers" the previously used screen within a group (in this case it is the Service group).
Each service screen (as all other screens) **can be displayed in each control mode any time**.
Actions (except for PARAMETERS and PLC screens) can be executed on the service screens in each control mode, but *only if Service Actions function on SECURITY PANEL is enabled*. Action execution can be implemented as the effect of action menu button .

3.3.1 Parameters



PARAMETER screen displays and edits all control parameters. Apart from this parameters can be transmitted to or received from external device through serial channel RS-232C by means of this function.
Parameter display is possible in all control modes. The main parameter groups can be seen on the diagram. The bar can be moved along the main groups with the help of cursor buttons: ↑ (Up), ↓ (Down). If a group is to be opened (E.g. on the diagram it is the SERIAL group) pull the bar to the desired main group than press button → (Right). In this case a further level is opened and the menu of subgroups within the selected main groups are displayed on screen. Likewise the subgroups can be selected by the use of buttons ↑ (Up), ↓ (Down) than the selected parameters can be displayed as the effect of button → (Right).

Backwards the procedure is as follows: the subgroup is returned as the effect of button ← (Left) than by the repeated press of button ← the main group is displayed.

A separate chapter of this manual contains the detailed list and interpretation, value limits, dimension of parameters.
The modification of parameter values whether by means of editing or loading through serial channel is only possible in **edit mode**. (Caption **EDIT** in the 1st field of status bar.) Select edit mode on machine control panel 2 by pressing button or if the control does not contain machine control panel with the help of softkeys as discussed in "Operator's Manual". Afterwards press action menu button .
(If the action menu button is pressed and edit mode is not opened disqualifying symbol →← appears in the 7th field of status bar.) Henceforth the parameters can be edited, loaded and sent.

Editing parameters

Select the appropriate subgroup and open it. The *identifying number*, *name* and *value* of the parameter to be edited appears in the line above softkeys.
The parameter values can be modified by the use of *numeric keys*: 0, 1, ..., 9 as well as *sign key* +/–. Decimal point cannot be used in the course of parameter input.
As a numeric key is pressed the current parameter value disappears from the bottom data input line and the number pressed is displayed.

If a previous element of the digits under editing is to be returned use key (Double left) or (Double right). The number at which the cursor points can be overwritten by the use of numeric keys or deleted as the effect of button (del).

As the editing of the given parameter is finished the new value is registered in the list as the effect of any of buttons , , or .

In the course of parameter editing the control executes value limit test, provided the entered value can be displayed in the format recorded for the given parameter. If not, message DATA ERROR is displayed in the bottom line which can be canceled with he help of button (cancel). The parameter format is stated beside the parameter identification (number and name) in the detailed description of parameters .

The control burns in parameter values into FLASH ROM only if PARAMETERS screen is closed. In this case caption Burn gleams in the 4th field of status bar for 1-2 seconds.

Other PARAMETER actions

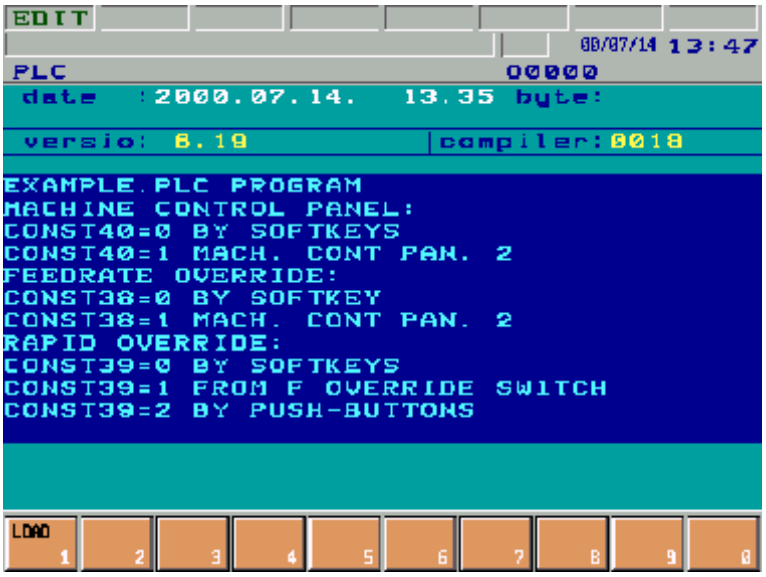
Load 1	Save 2	3	4	5	6	7	8	9	0

Load action menu: With the softkey pressed further three actions can be seen: **PC**, **Exec**, **Cancel**. If parameters are not to be loaded from serial channel but from PC connected optionally to control press softkey **PC**. Loading starts as the effect of key **Exec** and stops by the use of key **Cancel**.

Save action menu: With the softkey pressed further three actions can be seen: **PC**, **Exec**, **Cancel**. If parameters are not to be loaded from serial channel but from PC connected optionally to control press softkey **PC**. Saving starts as the effect of key **Exec** and stops by the use of key **Cancel**.

☞ *Warning! Before loading is started in serial channel make sure that parameters of serial transfer (BAUD RATE2, WORD LNG2, ect.) coincide both on NC side and the other side.*

3.3.2 PLC



Information serving the identification of PLC program loaded in control can be seen on PLC screen. Apart from this PLC program can be loaded from external device through serial channel RS-232C with this function.

View of PLC program information is possible in all control modes.

The date, hour and minute of PLC program compiling can be seen beside display **Date**.

The SW version of PLC executer burned in control PROM can be seen beside display **version**.

The version of the compiler transforming PLC source code into binary code can be seen beside display **compiler**.

In the following lines the list of text information written in **module :200** of PLC program is seen. If there is not enough room for the list on screen the text can be scrolled by the use of buttons , .

A separate manual deals with the PLC program and its compiling.

The PLC program **can be only loaded** in control. Neither editing, nor saving is possible.

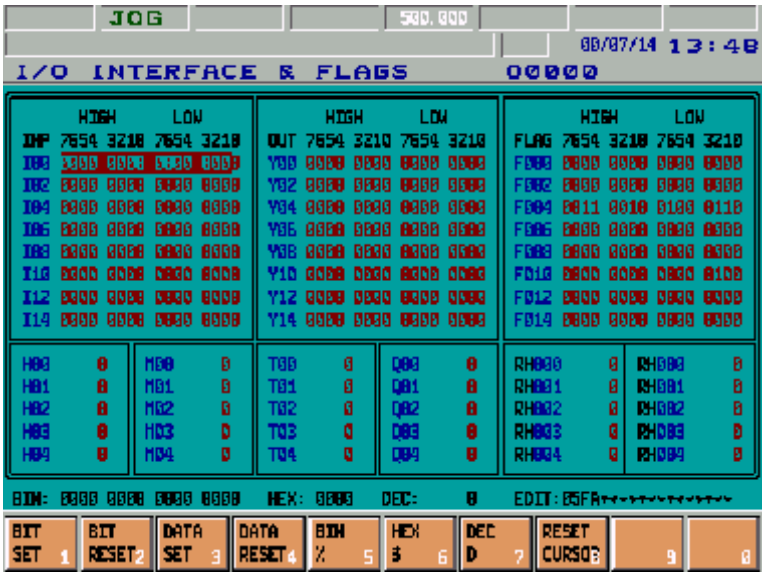
Loading is only possible in **edit mode**. (Caption **EDIT** in the 1st field of status bar.) Select edit mode on machine control panel 2 by pressing button or if the control does not contain machine control panel with the help of softkeys as discussed in "Operator's Manual". After wards press action menu button . The control only offers Load action:

Load									
1	2	3	4	5	6	7	8	9	0

Load action menu: With the softkey pressed further three actions can be seen: **PC**, **Exec**, **Cancel**. If PLC program is not to be loaded from serial channel but from PC connected optionally to control press softkey **PC**. Loading starts as the effect of key **Exec** and stops by the use of key **Cancel**. As key **Exec** is pressed the control automatically switches Machine On Request flag **Y540 off** thus causing **emergency state**. Henceforth the control can be restarted only upon **power-off** or with **restart without power-off** function.

☞ *Warning!* *Before loading is started via serial channel make sure that parameters of serial transfer (BAUD RATE2, WORD LNG2, ect.) coincide both on PC side and the other one.*

3.3.3 I/O Test



I/O test screen serves for displaying bi-state signals of machine interface as well as inner variables of PLC program.
By the use of this screen any bi-state output signal or flag can be set or reset.
The screen and its functions can be used in all control modes.
9 tables can be seen on screen.
Table **INP** contains the states of interface inputs (INT board inputs from I000 to I397) and input flags (from I400 to I997) in binary form. 16-bit-information can be seen in one line.
Table **OUT** contains the states of interface outputs (INT board outputs from Y000 to Y397) and output flags (from Y400 to Y997) in binary form. 16-bit-information can be seen in one line.
Table **FLAG** contains the states of inner variables of PLC program (from F0000 to F9997) in binary form . 16-bit-information can be seen in one line.
Table **H** contains the second timer values of PLC program (from H00 to H99) in decimal form.
Table **M** contains the minute timer values of PLC program (from M0 to M9) in decimal form.
Table **T** contains the 20msec timer values of PLC program (from T00 to T49) in decimal form.
Table **Q** contains the values of up-down counters of PLC program (from Q00 to Q31) in decimal form .
The following two tables show values of **RH** registers between NC and PLC (from RH000 to RH199). Expediently one should be set for displaying input registers while the other for displaying output registers.
In the last line of screen above softkeys the value of the selected variable can be seen in binary (**BIN**), hexadecimal (**HEX**) and decimal (**DEC**) form.
The highlighting bar can be moved among the 9 tables with the help of buttons and . If the desired table is selected the bar can be moved within the table by means of buttons , as discussed above. If the bar has reached the top or bottom of table it is scrolled within the window.
The table can be paged with the help of buttons and .
In the upper three tables, in which the variables are displayed in binary form the cursor can be moved within the bar by the use of buttons , hereby even one bit can be selected.
If action menu button is pressed the following actions are offered:

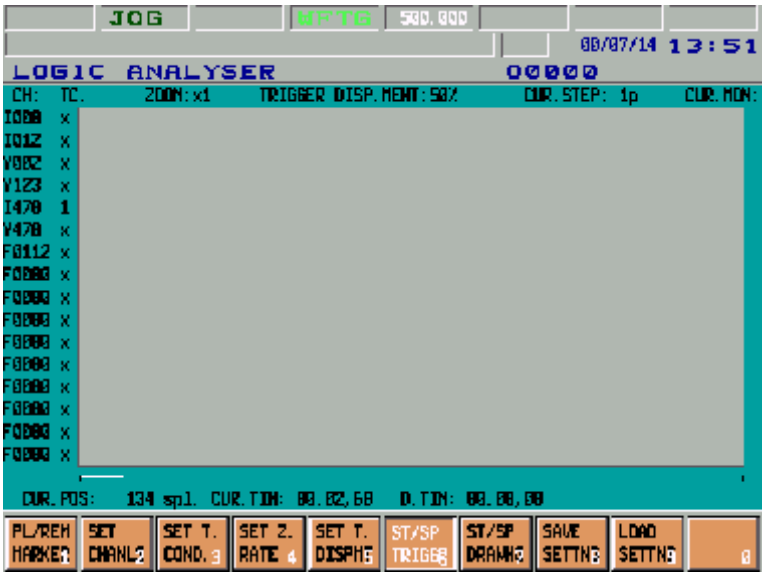
Bit set 1	Bit Reset 2	3	4	5	6	7	Reset cursor 8	9	0

Bit set action: If an element of table **OUT** (Ynnn) or **FLAG** (Fnnnn) is selected with the help of bar and cursor, the selected bit is set to 1 as the effect of key **Bit set**. The setting appears on screen unless the PLC program sets flag cyclically back to 0.

Bit reset action: If an element of table **OUT** (Ynnn) or **FLAG** (Fnnnn) is selected with the help of bar and cursor, the selected bit is set to 0 as the effect of key **Bit reset**. The setting appears on screen unless the PLC program sets flag cyclically back to 1.

Reset cursor action: As the effect of the key the bar moves to the top left corner of screen to window **INP** and the first page of the tables is displayed in all windows.

3.3.4 Logic Analyser



The timing diagrams of bi-state signals of I/Os and inner PLC program variables can be drawn with the help of logic analyser. The logic analyser together with its functions can be activated in all control modes any time.

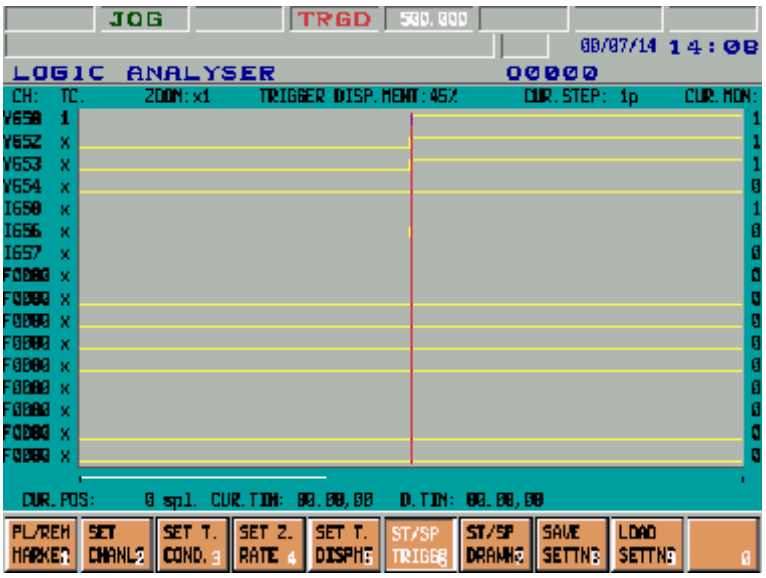
16 channels are available for signal test. The signal or flag of which is to be drawn can be set for all channels (**Set channel**). The signal or flag to be drawn is signaled with its appropriate PLC program letter (**I, Y, F**). Also the state of timers (**M, T, H**) and counters (**Q**) can be displayed with the obligation that if the counter or timer value is 0 the signal is also 0, while if the counter or timer value is >0 the signal is 1. The **channels** are **listed** on the left side of screen under caption **CH**. The condition (**Set trigger condition**), in case of which is true the data recording stops after a certain period of time can be set. The trigger condition state may be 0, 1 or x. Condition x means that the given signal does not take part in the trigger condition. Signals of all 16 channels can be put into the trigger condition, both with 0 and 1. If 0 is put into the trigger conditions the trigger event occurs when the signal state is 0, vice versa. If more signals act in the **trigger condition**, **AND** connection comes about between the signals. The set **trigger conditions** can be seen beside the channel names on the left side of screen in the second column under caption **TC**.

After function start (**Start trigger**) the signal states are continuously stored in a cyclic buffer. The data recording can also be stopped manually (**Stop trigger**). If the data recording is not stopped manually it goes on until the trigger condition becomes true and the cyclic buffer is filled in the proportion set as trigger offset. Till the trigger condition is false status **WFTG** (waiting for trigger) is seen in the 4th field of status bar. When the trigger condition becomes true status **TRGD** (triggered) can be read in the same place. Naturally all screens and modes can be opened as well as all control actions can be started during and after data recording.

Data recording is still carried on according to the value set with **Trigger displacement** function after the trigger condition has become true. This means, that following the trigger event the cyclic buffer is filled up to a point, so that recording before the event occupy the cyclic buffer in the proportion set in percentage of trigger displacement. The default trigger displacement value is 50%, meaning, that the trigger event is in the middle of cyclic buffer. The trigger offset value can be seen in the top middle part of screen after caption **TRIGGER DISP.MENT** in percentage.

The data recording can be stopped before or after the trigger event with the help of **Stop trigger** function.

As the effect of **Start drawing** function the signals are drawn on screen so that the trigger event is seen in the middle of screen. The resolution on the horizontal (time) axis is 1pixel/20msec.



The trigger event is shown by a **marker** drawn vertically across the screen. Another vertical, mobile marker can be pulled right or left by means of cursor buttons → , and ← . **The location of mobile marker** according to the trigger event along the horizontal axis is shown on the bottom of screen in display **CUR.POS** in **pixel**, while in display **CUR.TIM** in **minute, second, hundredth second** unit. The signal level is displayed for all channels as **0** or **1** conforming to the mobile **marker** location on the right side of screen under caption **CUR.MON**.

The marker can be moved along the entire recording with cursor buttons → and ← . The movement unit per button pressing is shown in **pixel** in the upper part of screen in display **CUR.STEP** . The movement unit can be increased or decreased by the use of buttons ↑ , ↓ .

The moved marked can be put to any screen position if **Place marker** function is used. The positioned marker can also be removed if the mobile marker is moved to the positioned one and **Remove marker** function is switched on. Display **D.TIM** in the lower part of screen shows the distance between the mobile marker and the last-positioned one in **minute, second, hundredth second** unit.

If action menu button is pressed the following actions are offered:

Pl/Rem marker 1	Set channel 2	Set t. cond. 3	4	Set t. dispmt 5	St/Sp triggr 6	St/Sp drawng 7	8	9	0

Pl/Rem marker action: (Place remove marker) Bifunctional switch. If the softkey is depressed as the effect of its pressing a marker is put down to the position of mobile marker. The softkey remains pressed down. The distance between the mobile marker and the last-positioned marker is shown in display D.TIM till the softkey is pressed. Depress the softkey. If a mobile marker is moved to the positioned one as the effect of its pressing the positioned marker is removed from screen.

Set channel action: Switch. When the softkey is pressed the channels can be edited. The channel names are seen on the left side of screen in column **CH**. The cursor can be moved along the channel names with the help of softkeys ↑ , ↓ .

Meanwhile the name of selected channel can be seen in the bottom right corner of screen beside caption **SET CHnn** in the edit field visible in the pressed state of Set channel softkey. Number nn indicates the channel number from 1 to 16.

Press the identification letter of PLC variable to be displayed on the alphanumeric keyboard, e.g..

character **I** in case of input test, than enter the identification number of variable by the use of numeric keys. The data input can be closed with buttons [↑], [↓] and the edited data is displayed in column **CH**.

Set t. condition action: (Set trigger condition). Switch. When the softkey is pressed the trigger conditions can be set. The trigger conditions can be seen beside the channel names on the left side of screen in the second column under caption **TC**. The cursor can be moved along the trigger conditions with the help of buttons [↑], [↓].

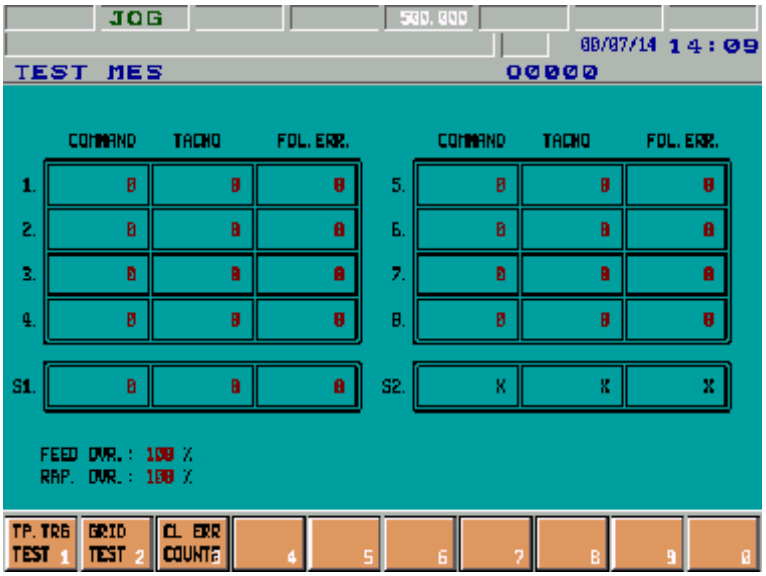
The trigger condition can be set by entering 0, 1 from numeric keys or "x" with the help of space button [ ].

Set t. dipmt action: (Set trigger displacement) Switch. When the softkey is pressed the trigger offset can be set. The trigger offset value is seen in % in the top middle part of screen beside caption **TRIGGER DISP.MENT**. The offset value can be increased or decreased in 5 % steps as the effect of buttons [↑], [↓] in value range 5% and 95%.

St/Sp triggr action: (Start/Stop trigger) Switch. After the channels, trigger condition(s) and trigger offset is set the data recording is initiated as the effect of this softkey. Data recording is executed in the pressed state of the softkey. If the recording is to be stopped press the softkey again, hereby the function is switched off and the softkey is "depressed".

St/Sp drawng action: (Start/Stop drawing) Switch. As the effect of the softkey the recorded data is drawn on screen so that the trigger event appears in the middle of screen. It remains pressed till drawing goes on.

3.3.5 Measuring System Test



The value of the most essential variables of position control loop can be displayed with the help of measuring system screen. Apart from this the states of the four probe inputs can be displayed as well as the number of incoming pulses between two spindle encoder zero pulses can be counted. The measuring system function together with its actions can be displayed in all control modes any time.

Two tables can be seen on screen. The table lines refer to the different axes (from 1 to 8), as well as to the spindles (S1, S2). The table columns show the different variables of position control loop. Variable **COMMAND** is proportional to the number running to D/A converter, from which the drive command signal is generated. Variable **TACHO** is proportional to the number of pulses coming from the encoder within a time unit. Variable **FOL.ERR** shows the following error in output increment. For the flow chart of position control loop and the above variables see chapter ? on page ?..

The feed rate and rapid traverse rate override switch states are also displayed on the bottom of screen.

If action menu button is pressed the following actions are offered:

Tp.trg test 1	Grid test 2	Cl. err countr 3	4	5	6	7	8	9	0

Tp. trg test action: when the softkey is pressed the states of probe signals PROBE1, –PROBE1; PROBE2, –PROBE2; PROBE3, –PROBE3; PROBE4, –PROBE4 coming through connector P1 of CPU board can be displayed in the bottom right corner of screen under the captions TTG1, TTG2, TTG3 and TTG4.

Grid test action: when the softkey is pressed the controlcounts encoder pulses between two zero pulses cyclically. The following captions appear in the bottom right corner of screen:

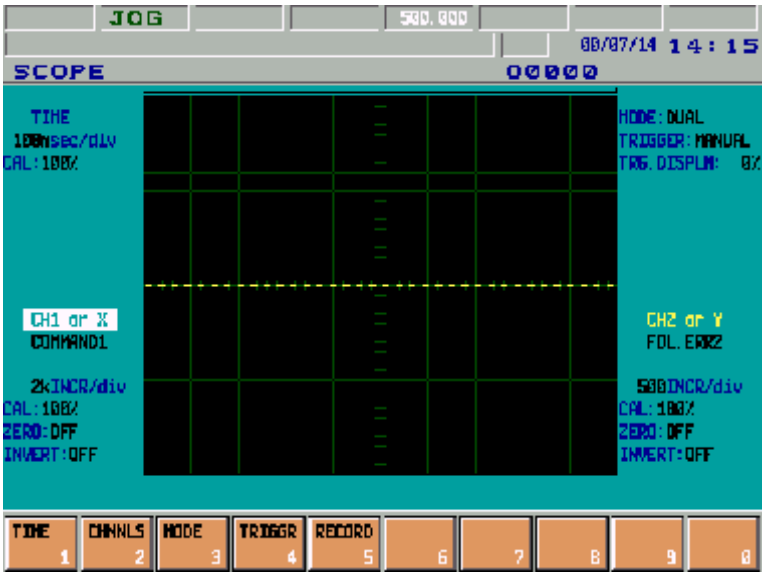
G.DIS: the number below shows the number of pulses between two spindle encoder zero pulses (if the spindle rotates). The pulse number is quadrupled, thus if the encoder resolution is 1024, than 4096 pulses should be counted.

ER.CT: error counter. It counts the cases when difference is registered between the number of incoming pulses and the quadruple of the value written at parameter 5023 **ENCODERS1**.

Cl. err. countr action: it deletes counter ER.CT provided Grid test softkey is pressed.

☞ *Warning!* *Grid test function disturbs spindle encoder flags I655 (revolution fluctuation), I656 ($n=n_S$) and I657 ($n=0$) therefore this function must be switched off after use!*

3.3.6 Oscilloscope



The timing diagrams of the most essential variables of position control loop can be displayed with the help of oscilloscope screen. Apart from this the change of two variables can be displayed in X – Y coordinate system. The scope function together with its actions can be displayed in all control modes any time.

The **time base** can be seen in time/division in the top left corner of screen under caption **TIME**. (Division or div is the distance between vertical lines seen on scope screen.) Beneath the calibration value of time base can be found in %.

The scope function mode is seen on the right side of screen beside caption **MODE**, the trigger source beside caption **TRIGGER**, while the trigger offset beside caption **TRG.DISPLM** in %.

The **name** of displayed signal and the **amplitude** can be found in the lower part on the right and left side under captions **CH1 or X** and **CH2 or Y** in increment/division unit. (Division or div is the distance between horizontal lines seen on scope screen.) Beneath the **calibration value** of amplitude in % as well as the state of switches **ZERO** and **INVERT** (ON/OFF) is seen.

If action menu button is pressed the following actions are offered:

Time 1	Chnnls 2	Mode 3	Triggr 4	Record 5	6	7	8	9	0

Time action menu: With the softkey pressed the following actions are available: **Time/div**, **Calibr**, **Positn**.

When softkey **Time/div** is pressed the time base can be set within value range 50msec/div and 10sec/div. The setting is executed by the use of buttons and .

When softkey **Calibr** is pressed the time/division dimension of time base can be attenuated within range 50% and 150%. By the use of buttons and the calibration value changes 1%, while with the help of buttons and it changes 10%.

When softkey **Positn** is pressed the signal can be pulled along the horizontal axis. It is moved 1 division by means of buttons , while 10 divisions with buttons and right or left.

Chnnls action menu: With the softkey pressed the following actions are available: **Input**, **Incr/div**, **Calibr**, **Positn**, **Zero (GND)**, **Invert**. The actions can be applied for both channels. Before starting

an action select the appropriate channel. The selection is shown by caption **CH1 or X** or **CH2 or Y** appearing in **inverse**. **Channel selection** is implemented with buttons and . Channels can be switched after any action selection, thus the selected action can be executed in both channels.

When **Input** softkey is pressed the signal to be connected to the input can be selected. The signal can be selected by the use of buttons , . As the effect of the buttons signals **NONE 1**, **FOL.ERR 1**, **COMMAND 1**, **TACHO 1** are at disposal. NONE means nothing is connected to the given channel. For other interpretations see the position control loop flow chart and the above variables in chapter ? on page ?.. The other signal identification is its number, i.e. the axis from which the signal is to be got. The numbers can be scrolled from 1 to 9 by the use of buttons and . Index No. 9 refers to spindle.

When softkey **Incr/div** is pressed the vertical resolution can be set within range 10incr/div and 20kincr/div, where signal ***k*** (kilo) indicates multiplicator 1000. The incr (increment) unit is always interpreted as output increment. Their setting is done by means of buttons , .

When softkey **Calibr** is pressed the further attenuation of value set for vertical resolution (Incr/div) is possible within range 50% and 150%. By the use of buttons and the calibration value changes 1%, while with the help of buttons and it changes 10%.

When softkey **Positn** is pressed the zero signal level can be moved vertically. The default zero signal level is in the middle. By the use of buttons and the zero level changes 1/5div, while with buttons and it changes 1div.

When **Zero (GND)** softkey is pressed, which is indicated by caption ZERO: ON on screen, 0 signal is drawn for the appropriate channel.

When **Invert** softkey is pressed, which is indicated by caption INVERT: ON on screen the signal inverse (–1 times) is drawn for the appropriate channel.

Mode action menu with the softkey pressed the following actions are available: **CH1**, **CH2**, **ADD**, **X–Y**.

When softkey **CH1** or **CH2** is pressed the signal of the first, second, or provided both are pressed of both channels are drawn. In this case caption CH1, CH2 or DUAL is seen beside caption MODE in the top right corner of screen.

When **ADD** softkey is pressed signals of channels CH1 and CH2 are added and the resulted signal is drawn up. Caption ADD appears beside MODE.

When softkey **X–Y** is pressed the signal of channel CH1 is drawn on the horizontal axis (X), while channel CH2 is drawn on the vertical axis (Y). Caption X–Y appears beside MODE.

Triggr action menu: With the softkey pressed the following action is available: **MANUAL**.

When **MANUAL** softkey is pressed caption MANUAL appears in the top right corner of screen beside caption TRIGGER:. This means that as **Record** is pressed the trigger is not awaited, but data recording is started immediately

Record action: After the desired values are set for recording, by pressing **Record** softkey the data recording starts. Till recording is in process caption RECORD is seen in the middle left part of screen. The data recording is stopped by the repeated pressing of **Record** softkey.

After a recording is finished and switched off by means of **Record** softkey the signal forms can be seen along the time axis. Open **Time** action menu and select **Positn** action. The recording can be viewed with the help of cursor and page buttons as discussed in case of the action. Any action, such as horizontal and vertical offsets, calibrations, inverting ect. can be executed on the finished recording, MODE setting can also be modified for the recording as well as added signals can be drawn up, even in plain X–Y.

If the recording is no longer needed it is deleted as the effect of button (del).

3.3.7 Version

VERSION screen gives information on HW/SW control version. This screen can be activated in all control modes any time.

The first digit (in this case 7) of the number beside caption VERSION (**7.nnn**) indicates HW version, while the three digits after the decimal point cover the SW version. This is followed by **(L)** or **(M)**, specifying if lathe or milling SW is in the machine.

Afterwards in the next line the different SW segments (Interpolator, Preprocessor, Diagnostics, System, Display, Editors) are listed. Segments can be selected with the help of buttons , . Further on the last modifications of the selected segment and their dates can be seen. The lines can be scrolled by means of buttons , .

3.4 Security Functions

Two kinds of security functions are built in the control:
– data security providing protection from unwarrantable interference at the user's interest, as well as
– dealer security providing protection for the dealer from illegal application of the copyrights involved in this product.
The expert installing the control must take care of the activation of both security functions.

3.4.1 Data Security

The control provides wide-range data security service. The SECURITY PANEL screen is found in **Setting action menu**. Select **Lock function** from Settings .
The picture shows the SECURITY PANEL screen. When the ***general security gate is open*** the other security gates have no significant role, thus ***all actions*** listed on screen ***can be executed*** even if symbol is displayed beside the action.

If however the ***general security gate is locked***, i.e. symbol is seen beside the caption the ***actions, beside*** the name of which ***lock*** symbol is displayed, ***cannot be executed***. If e.g. parameters are to be edited and this action is locked display **!** in the 7th field of status bar warns us that this action is closed in case action menu button is pressed on parameters screen.
The ***general security gate***, the ***DNC channel***, the ***parameters***, the ***PLC program*** and the ***service operations*** have
generated code, or
PLC key,
meaning that in case of opening, either as an answer to the digits displayed by the control another number generated from those digits must be given, or the security gate can be opened in the open (enable) state of the key switch mounted on the machine.
The other functions have
fix code, or
PLC key,
meaning that these functions are opened either with a code given in the below table or in the open (enable) state of the key switch mounted on the machine. .

The below table contains the codes of the appropriate functions:

Function	Code	Function	Code
General Security Gate	**Generated**		
work offsets	**15962**	open new program	**95148**
relative position	**15962**	delete program	**95148**
tool offsets	**15962**	edit program	**95148**
tool pot table	**15962**	load program	**95148**
tool life table	**15962**	save program	**95148**
timers and counters	**7895123**	protect program	**7895123**
PLC table	**15962**	DNC channel	**Generated**
#100 macro variables	**95148**	user's parameters	**7895123**
#500 macro variables	**95148**	parameters	**Generated**
run in auto menu	**456852**	PLC program	**Generated**
run in MDI menu	**357159**	service operations	**Generated**

Symbol ☜ (cursor) can be moved to the desired data security service within a column by means of buttons and . If columns are to be switched use buttons , .

If action menu button is pressed the following actions are offered:

Open 1	Close 2	3	4	5	6	7	8	9	0

Open action: If a locked function is to be opened and **security key** is at disposal move symbol ☜ (cursor) to the function. Turn the data security key to enabe position on the machine than press **Open** button.

If **no data security key** is on the machine move symbol ☜ to the function to be enabled than press **Open** button.

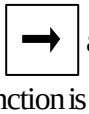
In this case, provided the function to be opened has **fix code,** message

Code: _ _ _ _ _ _ _ _

appears in the bottom line. After entering the appropriate fix code taken from the above table the data input can be closed with the help of button and the function is enabled.

If the function has **generated code** the following message is displayed in the bottom line:

nnnnnnnn code: _ _ _ _ _ _ _ _

where nnn is an eight-digit number. Start **Decoder program** on PC and enter the digits seen on control screen. The key code (a 5 number) generated by Decoder program must be entered from numeric keyboard to control. After the appropriate code is entered the data input can be closed by means of button  and the function is enabled.

Lock action: If a function is to be locked move symbol ☜ (cursor) to the function. Press **Lock** button.

The selected function is locked independent of the state of the general security gate.

3.4.2 Dealer Security

The dealer security function built in the control is activated after **15*24 power-on hours** have elapsed. (Power-on hour is the number of hours the control is in power-on state.) Henceforth a division enable is retracted on the feed rate override switch in every **24 power-on hours**.
This means that if the user sets feed rate override switch to 120% after (15+1)*24 power on hours the % (override) value seen beside current feed rate display (F) shows only 110% which is also the real movement rate. As 30*24 operation hours have elapsed the machine stops and the feed rate override percent value beside display F is **0%**.
Select

MESSAGE screen from **CHECK** screens. Enter

N C T characters from alphanumeric keyboard.

In this case a series of numbers (8 digits) appear in the top left corner of screen.
Start **Decoder program** on PC and enter the digits seen on control screen. The generated key code (a series of numbers of 5 digits) must be entered from numeric keyboard to control. The data input must be closed by means of button [→]. *Take care of not touching the control keyboard till the key code is entered if the digits are already seen on screen.*
By paging back set feed rate switch to 120% and check on screen if the control has accepted the code.

3.4.3 Decoder program

The decoder program may only be applied by the official dealers of NCT Automation Kft. according to the Licence agreement accepted in the course of program installation. If you are not legal user of the program or it is not your property WE HELP YOU. Call NCT Automation Kft in the following number:

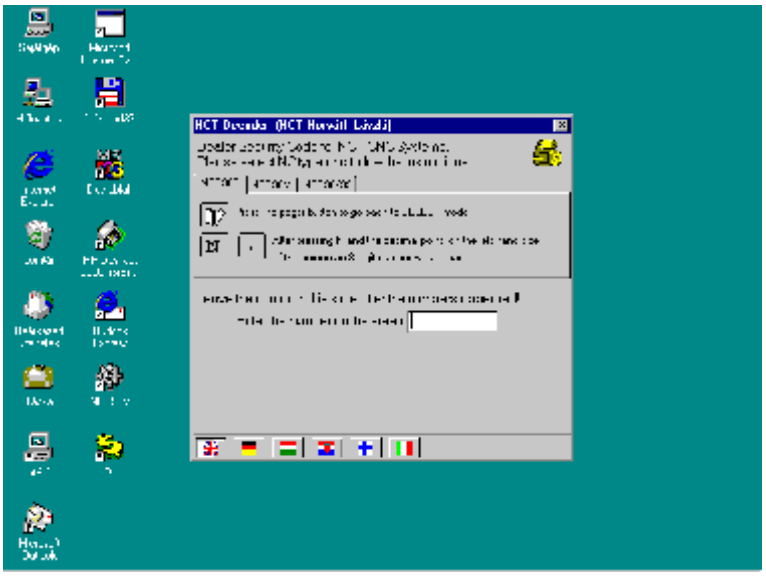
☎ + 36 1 467 63 00

The decoder program is a PC application, which is capable of

– giving the code for opening functions with generated code security,

– as well as delaying or canceling

dealer security function.
After opening the program click to **NCT98/99 tap** on decoder's panel.



Opening security gates

Enter the number displayed by the control on SECURITY PANEL screen. Thus the Decoder program gives a series of numbers, by the entering of which the gate is opened.

Dealer security code

Enter the number displayed by the control on MESSAGES screen.

In this case two buttons appear on the panel:

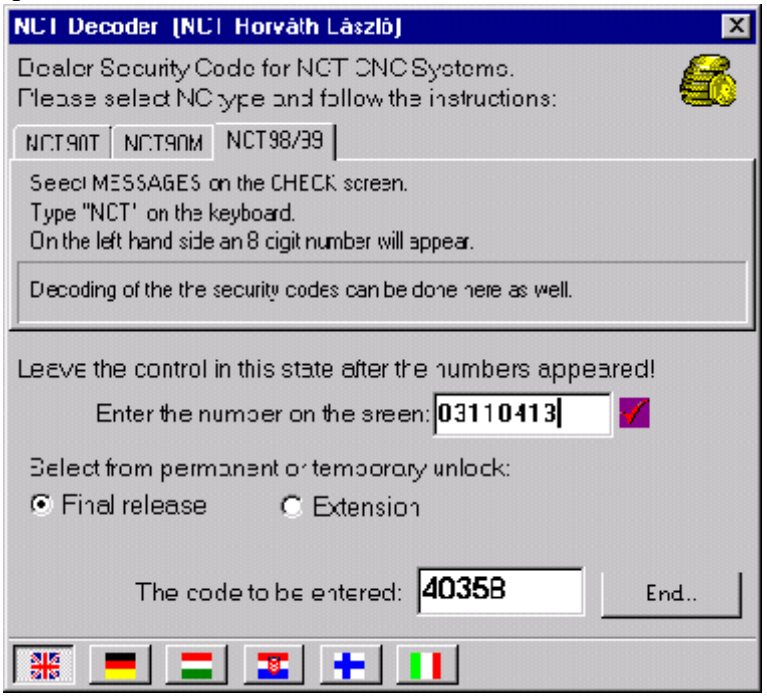
" Final release

" Extension.

If final release is selected the data security function ceases.

If only extension is ordered the number of days can be set by pulling the pot. Every day stands of 24 power-up hours, therefore if the machine is used only 8 hours a day and than turned off the enabled feed rate override decreases on every third day.

Afterwards enter the number given by the decoder to the control.


NCT Decoder [NCT Horváth László]
Dealer Security Code for NCT CNC Systems.
Please select NC type and follow the instructions:
NCT9MT
NCT9MM
NCT98/99
Select MESSAGES on the CHECK screen.
Type "NCT" on the keyboard.
On the left hand side an 8 digit number will appear.
Decoding of the the security codes can be done here as well.
Leave the control in this state after the numbers appeared!
Enter the number on the screen: 03110413
Select from permanent or temporary unlock:
Final release
Extension
The code to be entered: 40358
End..

3.4.4 Enable of Data Security Opening with PLC Key

PLC output flag **Y543** PLC serves for the enabling of data security opening. If the flag is on (state 1) **Open** action on SECURITY PANEL screen is effective for all functions. If however the flag is off, (state 0) **Open** action is only effective with the appropriate code entered.

The signal of key switch mounted on the machine can be copied to flag Y543.

The data security can also be hacked by the use of flag Y543 by opening I/O TEST screen of service functions (see chapter 3.3.3 on page 71.). Afterwards, provided Service functions of SECURITY PANEL are enabled, flag Y543 must be set to 1with the help of **Bit set** action. Than by paging back to SECURITY PANEL screen all functions can be opened.

The above possibility can be excluded in two ways: either by setting Y543 cyclically to 0 in module :001 in PLC program,

```
:001
...
D543            ;disable data security opening
...
J1
```

or by locking Service function and General Security Gate of SECURITY PANEL.

4 CONTROL INSTALLATION

The above descriptions refer to chapters INSTALLATION AND SERVICE FUNCTIONS OF CONTROL and PARAMETERS.

4.1 The First Steps

Before the control is powered check the connections, especially those of supply voltage. Check the supply of control and operator's panel. Check the supply voltage connections of INT board as well as of encoders and optional probe interface electronics. Check if the voltage in the different connectors is not higher than enabled. (E.g. 110V or 220V in INT board.)

1 ***Turn on*** the control.

2 If message ***Parameters – Error*** emerges in the start-up procedure press button (reset) (see chapter 3.1.2 on page 61). If the start-up is still not continued open SERVICE UTILITIES mode (chapter 3.2.1 page 64) and select F2 – BOOT PARAMS function of SERVICE MEMORY functions. Go on by executing WARM RESTART.

3 If the first phase of start-up procedure is done (chapter 3.1.1 page 60) and when entering the second phase (chapter 3.1.3 page 62) ***nothing is seen on screen*** (it is empty, e.g. pure white), open SERVICE UTILITIES mode (chapter 3.2.1 page 64) and select F1 – RAM TEST, than F4 – CMOS RAM CLEAR, than F5 – FLASH ROM CLEAR function of SERVICE MEMORY functions. Afterwards return to SERVICE MEMORY functions by means of button and select F2 – BOOT PARAMS and F3 – BOOT PLC functions in this order. Go on by executing WARM RESTART.

4 If in the 2nd phase of start-up procedure (chapter 3.1.3 page 62) message ***PLEASE LOAD A PLC PROGRAM*** is displayed, either activate SERVICE UTILITIES mode (chapter 3.2.1 page 64), and select F3 – BOOT PLC function of SERVICE MEMORY functions, or send a PLC program through serial port.

5 Delete the forthcoming ***error messages*** by the use of button (reset). (Chapter 3.1.3 page 62.)

6 Check if the ***number of softkeys*** drawn on screen corresponds to that of softkeys mounted under the monitor. If not follow the description of chapter 3.1.4 on page 62..

7 Check the ***monitor coloring*** i.e. the information can be clearly seen on all screens. If not, set parameter 0521 **USERCOLOR** to 0, while parameter 0522 **BORDER** to 7, meaning that the default coloring is in effect. Parameter editing is contained by chapter 3.3.1 on page 67, as for parameter description it is in chapter 5.3 on page 129..

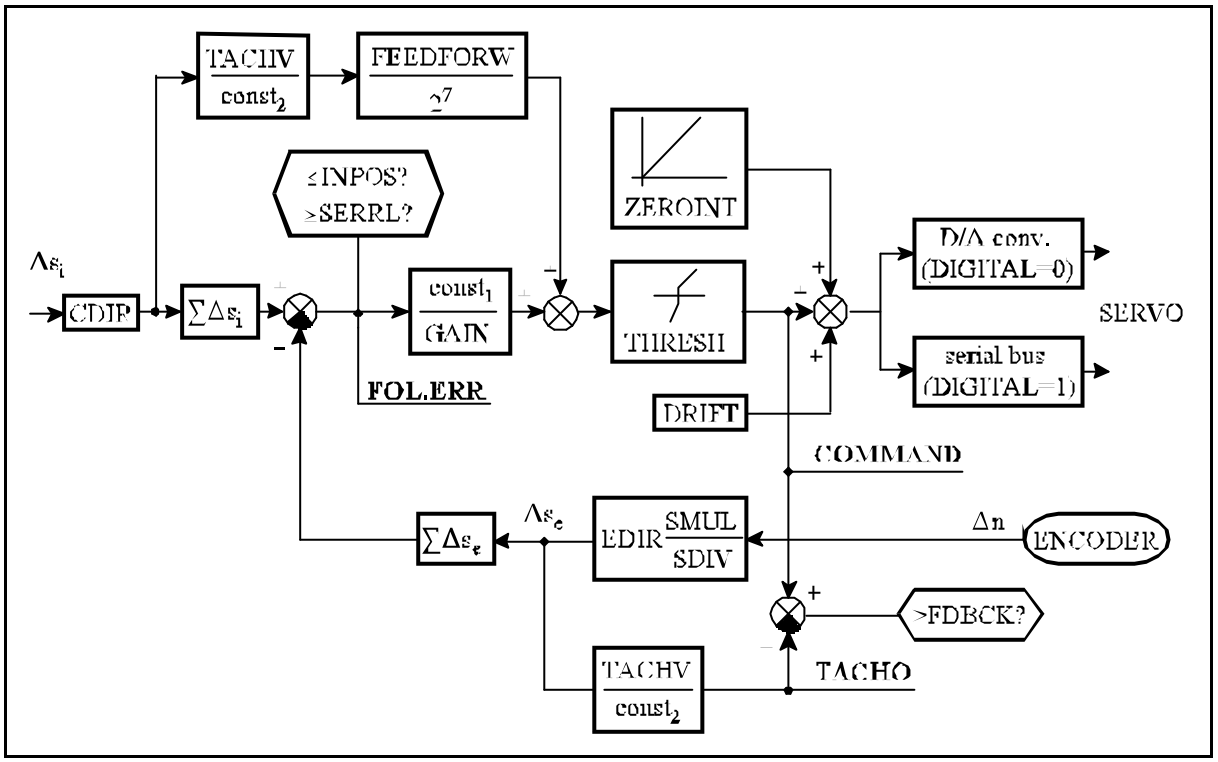
8 Set the ***language to be used*** in parameter group **0501 LANGUAGE**.

9 Set ***serial transfer parameters*** (in SERIAL parameter group, see also chapter 2.7.2 on page 40.) and load parameters saved in the course of a previous installation. If there is not any enter the parameter belonging to the appropriate group manually before each set-up procedure.

10 Load a ***PLC program***. This program should at least handle emergency circuitry, limit switches and deceleration switches, as well as be capable of turning the machine, the auxiliary drive and the main drive on.

4.2 Set-up Procedure of Position Control Loop

Before the set-up procedure of position control loop is initiated the emergency circuitry must be set up in PLC in order to turn the machine on as well as to execute emergency stop. The switching of auxiliary drives must be enabled as well as its velocity control loop must be adjusted and optimized.
Below the flow chart of position control loop can be seen, indicating the names of parameters, with which intervention can be made at the different points. The movement coming from the interpolator is assigned Δs_i while that coming from path measuring encoder with Δs_e on the diagram within a time unit. The signals (COMMAND, TACHO, FOLL. ERR), the values of which can be displayed on TEST MES screen (see chapter 3.3.5 on page 76) as well as can be drawn by means of the scope built in control (see chapter 3.3.6 on page 77.) are also indicated on the flow chart. The points, at which value limit comparison is executed by the control as well as the names of parameters, which can influence the limit comparison (INPOS, SERRL, FDBCK) are also indicated on the flow chart. The generated velocity control loop command signal may be transmitted in analog form after D/A conversion or digitally through CAN bus.



Below the drive is presumed to be optimized and appr 10V command signal input belongs to the rapid traverse revolution. The emergency stop button is pressed.

1 Enable the servo handler on the physical axes built in the machine by setting the appropriate parameters 444n **AXISTn** to 1. These may be NC or PLC axes as well as spindle provided rotary encoder is used on spindle. See also chapter 2.8.1 on page 45..
2 Select a physical axis number for each logic axis to be applied in parameter group **4281 AXIS**.
3 In case one of parameters 4287 **A**, 4288 **B** or 4289 **C** in AXIS parameter group is set to 1, i.e. address A, B or C is selected for axis the selected axis A, B or C must be decided to be a rotary

or a linear one. This is important since the inch - metric conversion is not valid for rotary axis (commands G20, G21). Consequently the control can only interpret standard addresses A, B, C for rotary axis. Set parameters 0181 **A.LINEAR**, 0182 **A.ROTARY**, 0184 **B.LINEAR**, 0185 **B.ROTARY**, 0187 **C.LINEAR**, 0188 **C.ROTARY** in IPLCONST parameter group appropriately.

4 Set parameter 446n **NOLOOPn** to 1 on built in axes.

5 Fill out parameter 4763 **INCH DET** in function of the length measuring systen being in inch or metric.

6 Select the increment system to be applied with the help of parameters 4764 **INCRSYSTA** , 4765 **INCRSYSTB** or 4766 **INCRSYSTC**. *All axes must function in the same unit and increment system in control.*

7 In case of lathe control set parameter 4762 **DIAM** to 1 in case the X coordinate data is to be displayed in diameter.

8 Set parameters 414n **SMULn**, 416n **SDIVn** regarding to the encoder resolution (in case of rotary encoders), the mechanic gear as well as on the basis of the selected increment system so that the necessary output increment is resulted.
Note, that when receiving TTL encoders the control automatically quadruples the encoder pulses, while when receiving sinusoidal encoders with option EXEI or EXEV it icosuples (multiplies by 20) the linear scale division.
Note, that the output increment system is 2 times the input one. Thus if in metric case increment system /b is selected (0.001 mm) then 2000 pulses has to be received from encoder for 1 mm.
That is if the thread pitch of ball screw is 10mm, the encoder resolution is 2500, 20000 pulses are needed. 10000 pulses result from automatic quadrupling therefore SMUL must be set to 2, while SDIV to 1.

9 Enter the rapid traverse rate for each axis at parameters 468n **RAPIDn**.
Parameter 478n **JOGRAPn** must be less than or equal to the value defined at parameter 468n **RAPIDn**.

10 Fill out parameters 474n **FEEDMAXn**. Initially start with 2000 mm/min or if the rapid traverse rate (RAPID) is less, with 50% of rapid traverse rate.
Let parameter 480n **JOGFMAXn** be equal to or less than the value written at the appropriate parameter 474n **FEEDMAXn**.

11 Initially write 500 at parameter 470n **ACCn**. Later on this value may be modified in function of system response.

12 Initially write GAINn=2*RAPIDn at parameters 402n **GAINn**.

13 Write SERRLn=GAINn-200 at parameters 406n **SERRLn**.
Write 5 for each axis at repetition number 418n **REPSLn**.

14 Let the start value of parameters 410n **FDBCKn** be 32000 for all axes,
as of parameter 422n **REPFBn** let it be 10.

15 Write 60 at parameters 426n **INPOSn** for all axes.

16 The following parameters must be zeroed: 412n **DRIFTn**, 424n **THRESHn**, 448n **ZEROINTn**, 450n **FEEDFORWn**,462n **GANTRYn**, 464n **MULGn**, 466n **DIFGn**.

17 Set parameters 440n **ENCDn** to 0 for all applied axes. Hereby the encoder wire break detection is on. If error message ENCODERn is sent check the encoder connections.

18 If possible, move all axes manually in both direction without turning the machine on and check on

position display if they **count** in both directions. If not, check the encoder connections.

19 Turn the machine tool on. As the position control loop is not closed on any axis all axes **crawl at offset**. In case the encoder cannot be moved manually on an axis check now on **position display** if it **counts**. If the creeping rate (offset) is high on an axis stop the movement by means of drift or offset potentiometer on drive.

20 Close position control loops in order one by one on connected axes by setting parameter 446n **NOLOOPn=0**. If an axis **overruns, positive feedback** is in effect. In this case set value of the appropriate parameter 432n **EDIRn** from 0 to 1, or inversely.

21 Check if the **axis movements** meet the selected increment size by means of incremental JOG. If not, set the encoder division, multiplication by overwriting parameters 414n **SMULn**, 416n **SDIVn** for the falsely set axes.

22 Check for each axis on the position display if the count direction (increasing numbers: + direction, decreasing numbers: – direction) corresponds to the positive and negative axis movement directions. If not, *after depressing the emergency stop button*, set parameter 430n **CDIRn** belonging to the appropriate axis from 0 to 1, or inversely.

23 Move axes by means of handwheel. Check for each axis if the movement is positive in case of rotating the handwheel in positive direction indicated on hanwheel cover. If not, set parameter 482n **HANDWHDn** belonging to the appropriate axis from 0 to 1, or inversely.

24 Program **1000 mm/min** (**40 inch/min** at parameter state 4763 **INCH DET**=1) feed rate on control. Optimize position control loop by setting the input signal divisor of drive while moving with the programmed rate. The below table shows the loop gain (1/sec) belonging to the appropriate lag (FOLER column TEST MES screen) in function of the position measure unit (parameter 4763 **INCH DET**) and the applied increment system (parameters 4764 **INCRSYSTA**, 4765 **INCRSYSTB**, 4766 **INCRSYSTC**).

	FOL.ER [output increment]			K [1/sec]
	INCRSYSTA =1	INCRSYSTB =1	INCRSYSTC =1	
INCH DET=0 F=1000 mm/min	100	1000	10000	333
	150	1500	15000	222
	200	2000	20000	166
INCH DET=1 F=40 inch/min	40	400	4000	333
	60	600	6000	222
	80	800	8000	166

In practical cases the position control loop gain is between 15..30 1/sec. If it cannot be optimally set by means of input divisor of drive modify parameter GAIN. By increasing the parameter the loop gain is decreased, while by decreasing the parameter the loop gain is increased.

25 The following error (lag) of the optimized position control loop in case of 1000 mm/min (40 inch/min) feed rate (F) is known from the previous point. Count the lag of the appropriate rapid

traverse rate (parameter468n **RAPIDn**) for the different axes (n) the following way:

$$lag_{RAPID_n} = lag_F \frac{RAPID_{max}}{F}$$

Set parameter GAINn as follows:

$$GAIN_{max} = 1.1 \cdot lag_{RAPID_n}$$

As for servo error limit:

$$SERRL_{max} = GAIN_{max} - 200$$

Program F=1000 mm/min (40 inch/min) feed rate again and while moving the axis set the optimized lag specified in the previous point by means of the input divisor of drive. Hereby the maximum ±10V analog command signal transmitted meets the maximum (rapid) traverse rate of the given axis (468n **RAPIDn**).

26 Move axes from program at rapid traverse rate programming **G0**. Examine the axis response. If necessary modify acceleration parameters **ACCn**.

27 Examine **1, 10, 100 increment sizes** with dial gauge. If the specified path is not accurately incremented, (the path left remains in lag), the situation can be bettered by increasing parameter 424n **THRESHn**.

28 In case of clamped axes clamping is initiated as the effect of In Position Signal, the window of which is served by parameter 426n **INPOSn**. In this case the signal limit may be narrowed for the exact positioning.
Since the axis may easily leave the narrow window as the effect of temperature drift set a low compensation value for automatic drift compensation at parameter 448n **ZEROINTn**.

29 Set parameter 404n **TACHVn** for each axis as discussed at the parameters.
Afterwards set parameters 410n **FDBCKn** and 422n **REPFBn** needed for feedback error detection. In case of fast, dynamic axes values FDBCKn and REPFBn must be lower, in case of slow, heavy axes they must be higher. Initially let them be FDBCKn=300, REPFBn=10.

30 Run a program, in which each axis executes rapid traverse (G0) movement separately for a few minutes in automatic mode. If error message FEEDBACKn is displayed in the course of running modify parameters FDBCKn and REPFBn.

4.3 Set-up Procedure of Reference Point Return

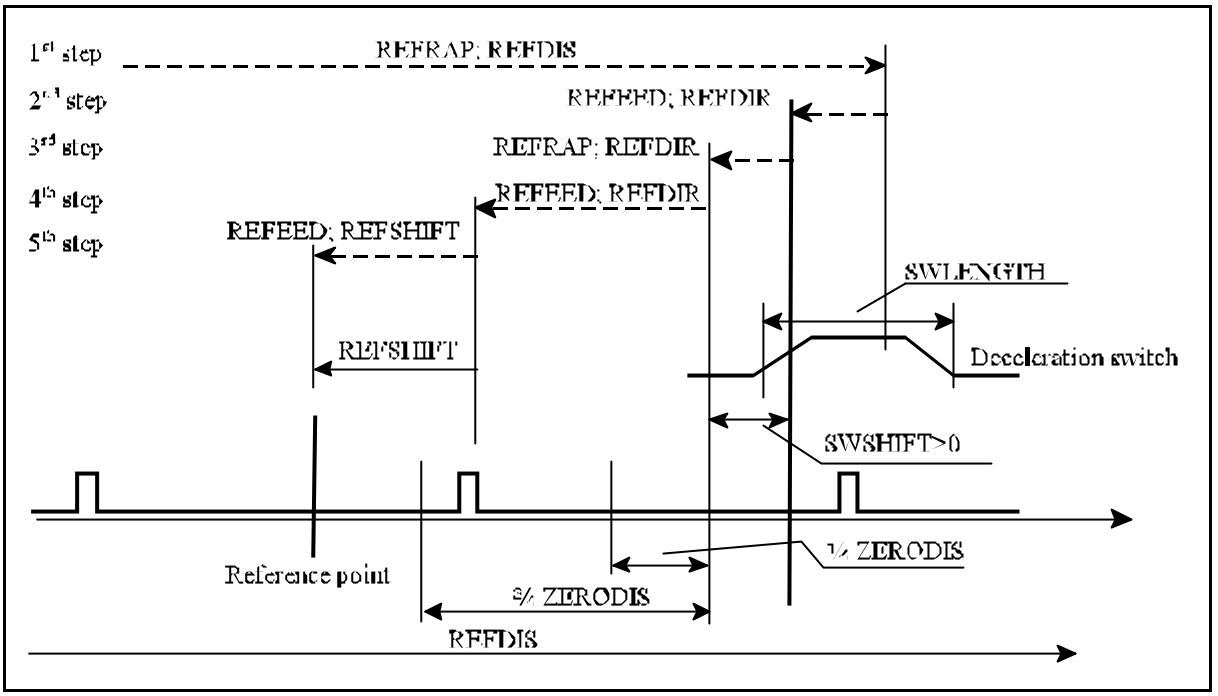
Servo loop setting is followed by reference point return. The setting of reference point return must be executed after position control loop is set up. Take care of copying the reference point deceleration switch states, if any, with the appropriate polarity to flags Y55n in PLC program.

After power-on the control has to search for a special position called reference point in order to move to absolute position. The control measures all coordinates according to the reference point. The control has a separate mode for reference point return.
The valid reference point return method can be determined for each axis one by one with the help of **REFTYPE** parameters. The reference point return (orientation) method valid for the spindle can be determined in parameter group SORIENT1,2 in SPINDLE parameter group. Therefore 8 parameter groups can be found with the name of **REFTYPE** in REFPAR parameter group (726n **REFTYPEn**), i.e. one group belongs to each axis. The following reference point return methods can be selected:

MACHINE: reference point return after running against deceleration switch
FLOAT: floating reference point return
GRID: reference point return on grid
DISCODED: reference point return with distance coded scales or rotary encoders

Below the procedure of each reference point return method is described and the parameters influencing the reference point return are also shown.

4.3.1 Machine Type Reference Point Return



Process of running to machinre reference point

A given axis of the control runs to a switch mounted on the machine in direction defined by REFDIS sign at REFRAP rate. The PLC program informs the control of the switch run event by setting flags **Y55n** to 1. It runs off the switch at REFEED rate in the switch run or the opposite direction defined by parameter REFDIR. Thereafter if parameter ZPULS is 0 it stops and acknowledges the position of running off as reference point, if parameter ZPULS is 1 it runs SWSHIFT distance, seeks for the first zero pulse than runs REFSHIFT distance and registers this position as reference point.

1 Select the valid reference point return method for each axis by filling out parameters **REFTYPEn**. On the axes, where machine reference point return is to be selected set the appropriate parameter **MACHINEn** to1.
2 Set the appropriate parameter 720n **ZPULSn** to 1 on the selected axes, provided the encoder zero pulse is to be used for reference point return.
3 On the axes, where machine reference point return is selected fill out parameters 700n **REFDISn**, 710n **REFRAPn** and 722n **SWLENGTHn**.
4 Enter the needed values 712n **REFEEDn** and 718n **REFDIRn** for each axis.
5 Enter the distance of two zero pulses projected to slide for each axis at parameters 714n **ZERODISn**. If this value is unknown for an axis temporarily select GRID reference point return method at parameter REFTYPE for the axis than set grid zero. In this case the axis position is 0 in the machine coordinate system, provided the value of the appropriate parameter REFPOS is 0, and no tool length offset is called on the given axis. Restart reference point return and examine the amount of slide movement on position display before it is re-zeroed by the next zero pulse. Enter this value at parameter ZERODIS. If the slide stops at the same zero pulse after the restart, first move 100...1000 increment by means of incremental jog in the direction of zero pulse search than

restart reference point return. Now the movement can be read and ZERODIS distance be stated. Reset the appropriate parameters REFTYPE.

6 Check on I/O TEST control screen if the appropriate flag **Y55n** is set to **1** by the PLC on the nth axis by pressing deceleration switch.

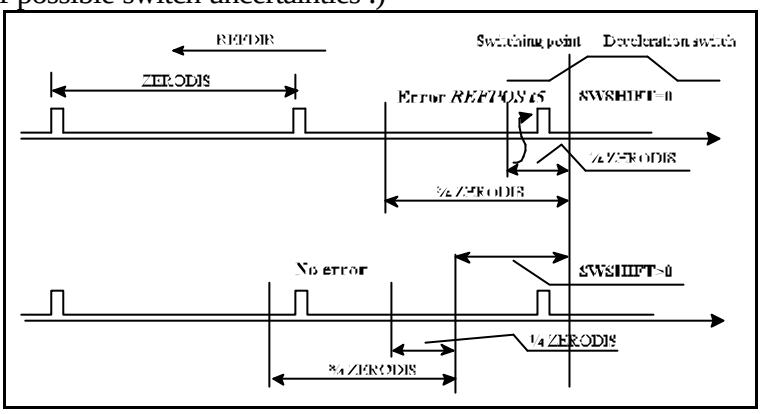
7 Start reference point return on the selected axes. The following error messages may arise in the course of reference point return:

A The slide searches the deceleration switch at REFRAP rate in REFDIS distance and direction. Error message *REFPOS t1* is sent, if the switch (flag Y55n=1) is not registered within the distance specified at parameter 700n **REFDISn**.

B The slide runs off the switch at REFEED rate in REFDIR direction. Error message *REFPOS t2* is displayed, if the run-off (flag Y55n=0) is not registered within the path specified at parameter 722n **SWLENGTHn**.

C Error message *REFPOS t5* is generated if the run-off (after flag Y55n transition 1→0) founds zero pulse within distance 3 ZERODIS. (This error message is displayed for if the zero pulse is too close to switch in some cases this zero pulse may be registered, while in some cases the one a period later because of possible switch uncertainties .)

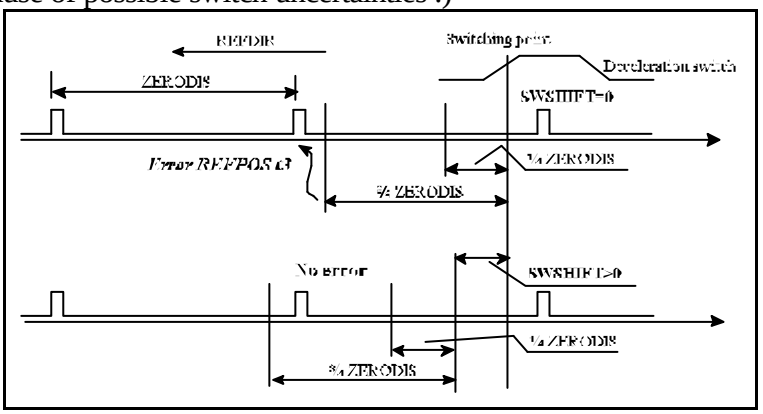
This error message can be avoided by writing an offset value at parameter 724n **SWSHIFTn** so the control moves SWSHIFTn distance after running off the switch (as if the switch were extended), and the zero pulse is searched only afterwards.



Reason for error message *REFPOS t5*

D Error message *REFPOS t3* is generated if the running off (after flag Y55n transition 1→0) founds zero pulse within distance : ZERODIS (This error message is displayed for if the zero pulse is too far to switch in some cases this zero pulse may be registered, while in some cases the one a period earlier because of possible switch uncertainties .)

This error message can be avoided by writing an offset value at parameter 724n **SWSHIFTn** so the control moves SWSHIFTn distance after running off the switch (as if the switch were lengthened), and



Reason for error message *REFPOS t3*

the zero pulse is searched only afterwards.

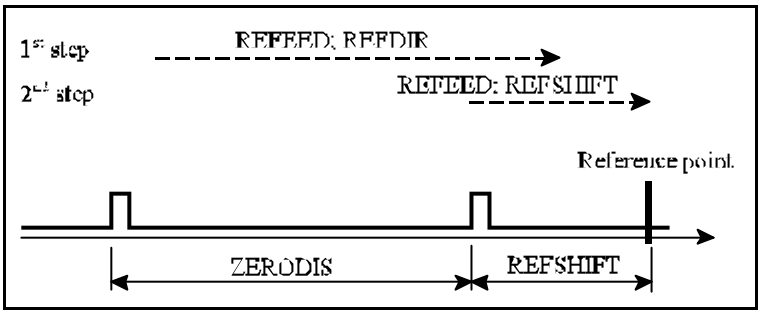
8 If a special axis position, e,g, position 0 deg of rotary table does not coincide with the zero pulse the reference point can be moved to the desired position with the help of parameter 716n **REFSHIFTn**. In this case after finding the zero pulse the appropriate axis moves this distance and registers the reference point afterwards.
9 In case the reference point must not coincide with the origin of machine coordinate system the offset can be set at the appropriate parameter **REFPOS1n** No. 702.

4.3.2 Floating Reference point return

The user must position the appropriate axis in manual mode and by pressing direction button of the selected axis in reference point return mode (as in case of axis movement) this position is regarded as reference point by the control.
On the axes, where floating reference point is to be selected set the appropriate parameter **FLOATn** to 1.

4.3.3 Grid Reference point return

The control seeks for the first zero pulse at FEFEED rate in REFDIR direction, than moves REFSHIFT distance and registers this position as reference point.

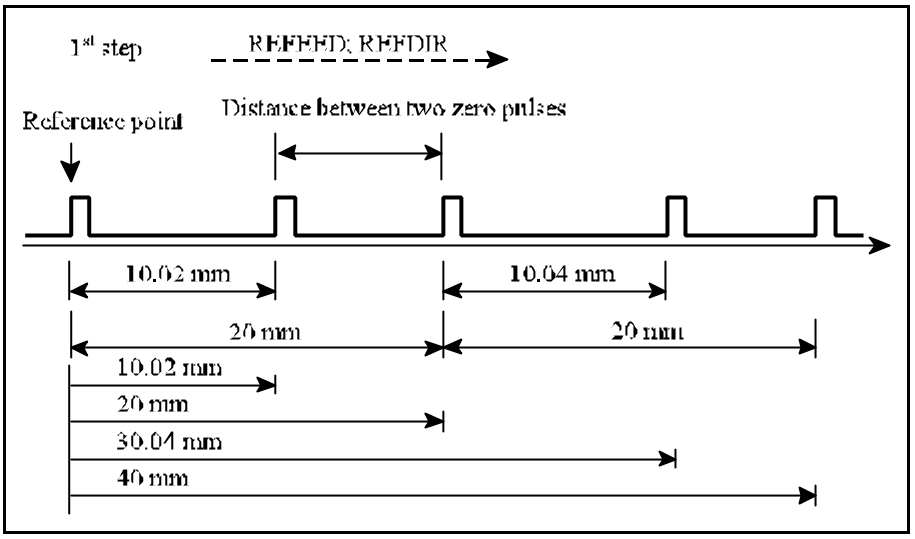


Process of reference point return on grid

1 Select the valid reference point return method for each axis by filling out parameters **REFTYPEn**. On the axes, where grid reference point return is to be selected set the appropriate parameter **GRIDn** to1.
2 Set the appropriate parameters 720n **ZPULSn** to 1 on the selected axes.
3 Enter the needed values 712n **REFEEDn** and 718n **REFDIRn** for each axis.
4 Enter the distance of two zero pulses projected to slide for each axis at parameters 714n **ZERODISn**. In case of rotary axis or if you want to avoid error message REFPOS t3 set this parameter 0.
5 Start reference point return on the selected axes. Error message *REFPOS t3* is sent during reference point return if no zero pulse is found within the double of ZERODIS distance.
6 If a special axis position, e,g, position 0 deg of rotary table does not coincide with the zero pulse the reference point can be offset to the desired position with the help of parameter 716n **REFSHIFTn**. In this case after finding the zero pulse the appropriate axis moves this distance and register the reference point afterwards.
7 In case the reference point must not coincide with the origin of machine coordinate system the offset can be set at the appropriate parameter 702n **REFPOS1n**.

4.3.4 Distance Coded Reference point return

This reference point return method can be used when applying distance coded linear scales and rotary encoders. In this case the control can decide the absolute position from the distance of two neighboring zero pulses. It starts to move at REFEED rate in REFDIR direction and perceives its position after detecting two zero pulses. Since the distance of zero pluses may alter on the different measuring tools the average distance of zero pulses must be defined for the control at parameter ZERODIS, which is 10000 on the diagram.



Process of distance coded reference point return

1 Select the valid reference point return method for each axis by filling out parameters **REFTYPEn**. On the axes, where distance coded reference point return is to be selected set the appropriate parameter **DISCODEDn** to1.
2 Set the appropriate parameters720n **ZPULSn** to 1 on the selected axes.
3 Enter the needed values 712n **REFEEDn** and 718n **REFDIRn** for each axis.
4 Enter the average distance of two zero pulses for each axis at parameters 714n **ZERODISn**.
5 The distance of fixed zero pulses is specified at parameter 724n **BASDISTn** in function of the signal period of the linear scale.
6 Start reference point return on the selected axes.
Error message *REFPOS t3* is sent during reference point return if no zero pulse is found within the duple of ZERODIS distance.
Error message *REFPOS t6* is displayed if the following relation is true for the number of pulses between two zero pulses:

$$\frac{ZERODISn}{500} * \frac{1}{4} \leq MOD \frac{pulsenumber}{\frac{ZERODISn}{500}} \leq \frac{ZERODISn}{500} * \frac{3}{4}$$

7 Make reference point return near to negative limit position. Register the axis position, namely Pnegative. Move near to the positive limit position, make reference point return and register the axis position namely Ppositive. The following relation must be true for the two registered positions:

Ppositive > Pnegative

If the above relation is not true, this means that the linear scale is mounted inversely according to

the necessary axis direction. In this case the sign of parameter 432n **EDIRn** in SERVO parameter group must be changed for the given axis. Consequently in order to avoid positive feedback the connection of signals A; –A must be reversed in the encoder connector.

8 In case the reference point (a linear scale end) must not coincide with the origin of machine coordinate system the offset can be set at the appropriate parameter 702n **REFPOS1n**.

4.4 Set-up Procedure of Stroke Limits

The setting of stroke limit can be initiated after reference point return. The control can handle two types of stroke limits:

– hardware signals of limit switches mounted on the machine,
– as well as software stroke limits adjusted on parameters

The limit switches mounted on the machine have the advantage of being active even before reference point return as opposed to software stroke limits effective only after reference point return, since the slide position is assumed to be known by the control in the absolute coordinate system.
The advantage of parameter limit position is that the control registers the limit position approach, thus it continuously decreases the feed rate and by the time it reaches the given position it stops contrary to the switch, in the case of which the deceleration is after the run on. The path for deceleration occupies machine working space to no purpose. The other advantage of software stroke limit is that the so called “check before move” function is built in control which is armed by state 1 of parameter 3163 **CHBFMOVE**. In this case during program execution before starting a movement block the control checks if one of the end positions of block is outside the limit or inside a forbidden area defined by the programmer. If yes, the block is not even started but error message *3056 LIMIT* or *3057 FORBIDDEN AREA* is displayed.
The two possibilities can also be applied simultaneously. In this case the adventages of the two limit position detections are added. To sum it up, software stroke limits should always be set, even if the machine is mounted with limit switches.

4.4.1 Setting of Stroke Limits with Switches

Two limit switches are needed for each axis, one in negative direction and one in positive direction. The state of negative limit switches must be copied to flag **Y57n**, while that of positive limit switches to flag **Y56n** in the PLC program. Note, that flag state 1 means that the axis is on limit position in either direction.
The limit position switches can also be used for deceleration switches. In this case in reference point return mode (Y400=1) the state of limit position switches must not be copied to limit position flags, otherwise the control sends limit position error. The reference point return must be set so that the axis changes direction after running to switch and leaves the switch that way.

4.4.2 Setting of Software Stroke Limits

☞ *Warning!* *If parameter 702n **REFPOSn** or 716n **REFSHIFTn** is modified the software stroke limit positions must be re-measured after setting.*

1 Set parameters **LIMBIT1n** to **0**, for the software stroke limit detection to be disabled.
2 Return to **reference point** on all axes.
3 Delete all length offsets and zero position offsets and use MACHINE POSITION screen for position display.
4 Move in positive direction on each axis to the stroke end. Enter the positions seen in the machine coordinate system display in input increment (i.e. the value in display without decimal point) at parameters **LIMP1n**.
5 Move in negative direction on each axis to the stroke end. Enter the positions seen in the

machine coordinate system display in input increment at parameters **LIMP1n**.

6 Set parameter **LIMBIT1n** to **1** on the axes, for which software stroke limit detection is to be activated. Henceforth the software stroke limit is active on these axes.

7 Check if the stroke limits are correct by moving in both directions on all axes.

☞ *Warning: Measure and enter stroke limits at parameters LIMP1, LIMN1 on axes X, Y, Z even if stroke limit detection is disabled on these axes at parameter LIMBIT1. This is necessary for the graphic display regards to the values written at parameters LIMP1, LIMN1 as initial working space.*

4.5 Compensating Mechanical Errors of Machine

Two possibilities are offered by the control for compensating mechanical machine errors:
- backlash compensation and
- pitch error compensation

4.5.1 Compensating Backlash Error

Measure the backlash error of the machine for each axis and enter the value at the appropriate parameter 110n **BCKLSHn** in COMMON parameter group. The backlash change error must be specified in input increment.

4.5.2 Setting Pitch Error Compensation

A memory area consisting of 900 compensation cells is available for the purpose of pitch error compensation of the ballscrew in the parameter store. These 900 compensation cells are allocated by the user at his/her discretion among the axes with the help of parameters in PTCHCMP parameter group. Since the ballscrew has slightly different inaccuracies of pitch error in positive and negative directions, the two directions can be compensated separately, at the same time this is also a possibility for compensation for location-dependent backlash. Therefore all axes must be measured and compensated both in positive and negative movement directions.

1 Before initiating compensation the following parameters must be filled out correctly, as well as the following set-ups must be executed: servo set-up, reference point return, software stroke limit definition, backlash error compensation (parameters BCKLSH).
2 Delete all work offsets and tool offsets in order to work clearly in machine coordinate system.
3 Select the axes on which compensation is to be executed and enable compensation at the appropriate parameters PTCHENn on those axes.
4 Decide the number of compensation cells on each axis. Enter the values at the appropriate parameter PTCHGRDn.
The stroke of each axis is calculated from the difference of stroke limit parameters LIMP1n) LIMN1n. The number of compensation values (PTCHVALnnn) to be used on a given axis is calculated from he following relation:

$$n = \left[\frac{LIMP1n - LIMN1n}{PTCHGRDn} \right] + 1$$

5 Specify the id. number of the compensation cell belonging to the reference point in positive and negative direction (No. nnn of parameter PTCHVALnnn). Enter the cell number at the appropriate parameters PTCHRFPn and PTCHRFNn.
6 Write a program moving the axis to be compensated both in positive and negative directions from limit position to limit position.. Examine the below program. Reference point: 300 mm (REFPOS11=3000000), positive limit position: 310.1 mm (LIMP11=310100), negative limit position:) 130.2mm (LIMN11=) 130200), width of the selected compensation cell: PTCHGRD1=10 mm:

```
%O7000(PITCH COMPENSATION)
G28 XI0
G0 X310 (first position in negative direction)
X300
X290
X280
X270
X260
X250
X240
X230
X220
X210
X200
X190
X180
X170
X160
X150
X140
X130
X120
X110
X100
X90
X80
X70
X60
X50
X40
X30
X20
X10
X0
X-10
X-20
X-30
X-40
X-50
X-60
X-70
X-80
X-90
X-100
X-110
X-120
X-130 (last position in negative, first position in positive direction)
X-120
X-110
X-100
X-90
X-80
X-70
X-60
X-50
X-40
X-30
X-20
X-10
X0
X10
X20
X30
X40
X50
X60
X70
X80
X90
X100
```

```
X110
X120
X130
X140
X150
X160
X170
X180
X190
X200
X210
X220
X230
X240
X250
X260
X270
X280
X290
X300
X310 (last position in positive direction)
M30
%
```

7 Run the above program in automatic mode by means of single block execution. Write the nominal X axis position read from the control position display as well as the real X axis position read from the measuring tool (e.g. laserinterferometer) at the end of each block in a table.

X_n: nominal position	X_a: current position	$D=X_a - X_n$	PTCHVAL numbering (-)	value C (-)	PTCHVAL numbering (+)	value C (+)	note
300,000	300,000	0,000					reference point
310,000	309,994	-0,006	201	-12			measuring in negative direction starts from here.
300,000	300,005	0,005	200	22			
290,000	290,008	0,008	199	6			
280,000	280,014	0,014	198	12			Formula defining the i^{th} value of compensation (C_i):
270,000	270,021	0,021	197	14			
260,000	260,022	0,022	196	2			
250,000	250,040	0,040	195	36			$C_i=(D_i–D_{i–1})*2000$
240,000	240,039	0,039	194	-2			
230,000	230,041	0,041	193	4			
220,000	220,048	0,048	192	14			
210,000	210,051	0,051	191	6			
200,000	200,068	0,068	190	34			
190,000	190,071	0,071	189	6			
180,000	180,072	0,072	188	2			
170,000	170,080	0,080	187	16			
160,000	160,087	0,087	186	14			
150,000	150,093	0,093	185	12			
140,000	140,100	0,100	184	14			
130,000	130,104	0,104	183	8			
120,000	120,108	0,108	182	8			
110,000	110,119	0,119	181	22			
100,000	100,119	0,119	180	0			
90,000	90,130	0,130	179	22			

X_n: nominal position	X_a: current position	$D=X_a - X_n$	PTCHVAL numbering (-)	value C (-)	PTCHVAL numbering (+)	value C (+)	note
80,000	80,135	0,135	178	10			
70,000	70,146	0,146	177	22			
60,000	60,146	0,146	176	0			
50,000	50,154	0,154	175	16			
40,000	40,158	0,158	174	8			
30,000	30,170	0,170	173	24			
20,000	20,171	0,171	172	2			
10,000	10,180	0,180	171	18			
0,000	0,187	0,187	170	14			
-10,000	-9,808	0,192	169	10			
-20,000	-19,802	0,198	168	12			
-30,000	-29,791	0,209	167	22			
-40,000	-39,791	0,209	166	0			
-50,000	-49,782	0,218	165	18			
-60,000	-59,775	0,225	164	14			
-70,000	-69,771	0,229	163	8			
-80,000	-79,759	0,241	162	24			
-90,000	-89,754	0,246	161	10			
-100,000	-99,745	0,255	160	18			
-110,000	-109,744	0,256	159	2			
-120,000	-119,734	0,266	158	20			
-130,000	-129,725	0,275	157	18	57	28	end of measuring in negative direction, start of measuring in positive direction
-120	-119,739	0,261			58	8	measuring in positive direction Formula defining the j^{th} value of compensation (C_j): $C_j=(D_j-D_{j+1})*2000$
-110,000	-109,743	0,257			59	22	
-100,000	-99,754	0,246			60	2	
-90,000	-89,755	0,245			61	14	
-80,000	-79,762	0,238			62	20	
-70,000	-69,772	0,228			63	4	
-60,000	-59,774	0,226			64	16	
-50,000	-49,782	0,218			65	16	
-40,000	-39,790	0,210			66	10	
-30,000	-29,795	0,205			67	24	
-20,000	-19,807	0,193			68	6	
-10,000	-9,810	0,190			69	14	
0,000	0,183	0,183			70	12	
10,000	10,177	0,177			71	6	
20,000	20,174	0,174			72	14	
30,000	30,167	0,167			73	18	
40,000	40,158	0,158			74	6	
50,000	50,155	0,155			75	20	

X_n: nominal position	X_a: current position	$D=X_a - X_n$	PTCHVAL numbering (-)	value C (-)	PTCHVAL numbering (+)	value C (+)	note
60,000	60,145	0,145			76	4	
70,000	70,143	0,143			77	24	
80,000	80,131	0,131			78	2	
90,000	90,130	0,130			79	20	
100,000	100,120	0,120			80	8	
110,000	110,116	0,116			81	6	
120,000	120,113	0,113			82	22	
130,000	130,102	0,102			83	4	
140,000	140,100	0,100			84	22	
150,000	150,089	0,089			85	14	
160,000	160,082	0,082			86	10	
170,000	170,077	0,077			87	6	
180,000	180,074	0,074			88	24	
190,000	190,062	0,062			89	-2	
200,000	200,063	0,063			90	12	
210,000	210,057	0,057			91	16	
220,000	220,049	0,049			92	14	
230,000	230,042	0,042			93	12	
240,000	240,036	0,036			94	12	
250,000	250,030	0,030			95	12	
260,000	260,024	0,024			96	8	
270,000	270,020	0,020			97	4	
280,000	280,018	0,018			98	10	
290,000	290,013	0,013			99	8	
300,000	300,009	0,009			100	22	
310,000	309,998	-0,002			101	-4	
				550		550	sum of compensation values

8 Calculate the difference of current (X_a) and nominal (X_n) positions, namely D. Write the numbers of compensation cells in the table both in positive and negative directions (columns PTCHVAL numbering ( )), as well as PTCHVAL numbering (+)).
The compensation value to be written in the i^{th} cell on the basis of the above table in case of movement in negative direction:

$$C_i=(D_i-D_{i-1})*2000$$

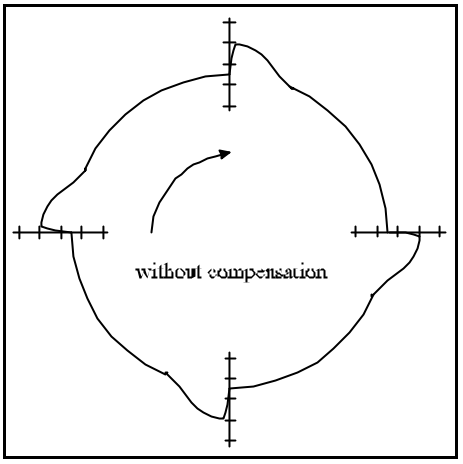
while in case of movement in positive direction:

$$C_j=(D_j-D_{j+1})*2000$$

Multiplicator 2000 in formula assumes metric system (INCHDET=0), 0.001 mm scale (INCRSYSTB=1) (1000), while the role of multiplicator 2 is that the compensation values are interpreted in output increment (0.5 µm).

9 Enter the calculated compensation value at the appropriate parameter PTCHVALnnn.

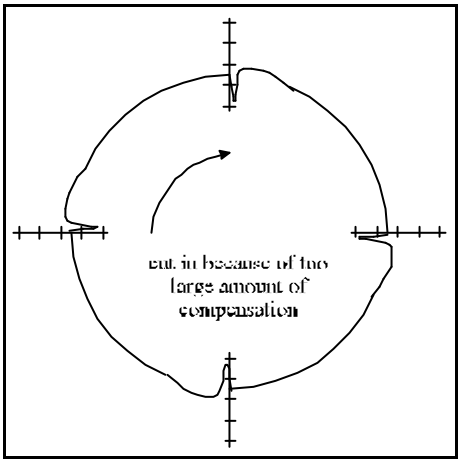
4.5.3 Task and Setting of Backlash Acceleration Function



If the backlash of the ball screw and the static friction are too great on the given machine, protuberances occur on the shape of a circle in case of circle arc machining after quadrant changes, i.e. the circle radius increases.
Provided the measuring system applied on the machine is indirect, i.e. rotary encoder, the shape error can be eliminated by compensating the backlash error (parameter BCKLSHn) and the static friction.
If however the measuring system applied on the machine is direct, i.e. a linear scale, the direction change, that is the period until the nut tails in from one side to the other one of the screw, cannot be compensated in the above way. In this case the nut must be pushed to the other side of the screw by sending an excessive speed command signal. This is called backlash acceleration.

☞ *Note: Backlash acceleration can only be applied in case of direct measuring system (linear scale). When using indirect measuring system (rotary encoder) the backlsh compensation value should be set by parameters BCKLSH!*

1. Program a full circle with diameter D=100 mm and record a circle shape error diagram at feed F500 mm/min. Measure the size of protuberances after the quadrant transitions. The protuberance is a consequence of the backlash of the ball screw and of the static friction.
2. Enable backlash acceleration function by setting BLACCEN=1. Define an initial value for the acceleration amount parameter and for the acceleration period, e.g. BLACCAMT=300 and BLACCPER=100 (msec). As the effect of this the excessive amount of command signal specified on parameter BLACCAMT, has to push the nut to the other side.



3. Define again circle shape error diagram with conditions listed in point 1. Increase parameters BLACCAMT and BLACCPER, should the error decrease, though the result is not acceptable yet. If the parameters set in the previous point are too great, over-compensation may occur, as a result of which the circle diameter falls abruptly, i.e. a cut is shown on the diagram.
4. Set feed values F100 and F1000 for the above circle shape error diagram. Enable ending of backlash acceleration on basis of path done by setting BLACCSP=1 and define an initial value for the distance, e.g. BLACCDIST=5, provided the circle error could not be minimized with the help of parameters BLACCAMT and BLACCPER.
5. Afterwards the circle shape can already be optimized by the changing of three parameters, namely the backlash acceleration amount (BLACCAMT), the backlash acceleration period (BLACCPER) and the backlash acceleration distance (BLACCDIST). (In case of low feed the

acceleration stop occurs rather on the basis of the period, as for high feed it is on the basis of the path done.)

4.5.4 Static Friction Compensation

1. Move the axis to be set in any direction, than wait for a while for the adhesion because of static friction to come into effect. Place a dial indicator on the slide in order to measure the steps. Move the axis 10 or 100 increments with incremental jog in the same direction. Static friction is detected when the slide does not move the selected increment.
2. Enable static friction compensation by setting SFRCMPEN=1. Set amount of compensation, e.g. SFRCMPAMT=100. Compensation works only if the given axis remains in stop state over the period set at parameter SPSTPER, i.e. during this time the slide adheres, that is the thickness of the lubricating film decreases. The time can be set in msec unit. Compensation may occur in case of low feed, should too little time be set. For a start let us set e.g. SPSTPER=500 msec.
3. Measure again adhesion because of static friction as discussed in point 1. If over-compensation occurs, i.e. over-travel is experienced after compensation and value SFRCMPAMT cannot be decreased further on, enable ending of compensation on basis of path done by setting SFRCMPSP=1. Set an initial value of SFRCMPDIST=5 for the distance parameter, meaning 5 increment.

4.6 Procedure of Spindle Parameter Setting

In order to set parameters concerning the spindle first the PLC program must be prepared for spindle operation.
If the spindle is mounted with encoder, decide, if signals spindle n=0 and spindle n=n_S are registered from flags I657 and I656 generated by the control or the signals sent by the drive are dealt with.

1 If the spindle is mounted with encoder, then enter the resolution of rotary encoder mounted on the spindle at parameter 5023 **ENCODERS1** as well as set parameter 4449 **AXISTS1** in SERVO parameter group to 1.
If no encoder is mounted on the spindle, then set both parameters to 0.
2 Write the XMU I/O used by the spindle at parameter 5025 **IOSELS1**.
3 First execute the setting of revolution values belonging to each range. The main drive is presumed to be set and calibrated to 10V command signal.
Program valid **revolutions S** for each range, possibly near to the top revolution limit of the range and **measure** the revolution. The revolution can be specified by means of a tachometer or if the spindle is mounted with encoder from control current revolution display. The revolution **calibration** of each range can be done by overwriting parameters 512n **S1 10Vn** (n: range number) according to the below relation:

$$S110Vn = \frac{n_{current}}{S_{programmed}} \cdot S110Vn$$

4 If exactly 10000 mV command signal must belong to the revolution specified at parameter 512n **S110Vn**, then set parameter 5021 **ADJUSTS1** as described.
5 Set parameters 514n **S1MINn**, 516n **S1MAXn** allowed for each range.
6 If necessary set the rising and falling rate of analog spindle signal at parameters 504n **S1ACCTn**, 506n **S1DECTn** (n: range number).
7 If the spindle is mounted with encoder and the PLC program applies flags **I656** (n=n_S) and **I657** (n=0), then fill out parameters 5005 **N%**, 5006 **NW**, 5007 **N0** as described.
8 If the spindle is mounted with encoder and the PLC program applies flag **I655** (spindle speed fluctuation function), then fill out parameters 5001 **TIME**, 5002 **SCERR**, 5003 **FLUCT%**, 5004 **FLUCTW** as described.
9 If the spindle is mounted with encoder, then test **thread cutting function**. Write the following line to control by means of single block execution: *G33 ZI–20 F1 S500 M3*. If thread cutting is not started, then check if the PLC returns spindle rotation flag **Y650=1** as well as rotation state **RH062=3, or 4**. If yes, reverse parameter 4309 **CDIRS1**.
10 If the spindle can be oriented (command M19), then set parameter 5281 **ORIENT1** to 1. It is independent of the spindle being oriented mechanically or with closing position control loop since drilling cycles (G76, G87) demanding function M19 are executed only this way.
11 If the spindle can be indexed, i.e. the position control loop can be closed, then set parameter 5282 **INDEX1** to 1. In this case set parameter 4469 **NOLOOPS1** in SERVO parameter group to 0.
Fill out all parameters with index ... S1 in SERVO parameter group as described in case

of the set-up procedure of position control loop.

12 Set parameters 5283 **GRID1** and 5284 **INDEX_C1** in the appropriate way.

13 Always set parameter 5242 **DIVS1** to 0!
If 5284 **INDEX_C1=0** define threshold number 5241 **M_NUMB1**.

14 Write function **M19** in **PLC program** as described in the Sample PLC program.

15 Set parameters 532n **GAIN1n**, 536n **ACC1n** (n: number of the range belonging to the different gears). Value 532n GAIN1n decreases in proportion of the gear increase.

16 Execute **M19** as the effect of which the position control loop is closed. Thereafter the set-up procedure of spindle servo corresponds to that described in SERVO parameter group, except for values **GAIN** and **ACC** that can be specified for spindle for each range. It is practical to start the set-up procedure of position control loop at the lowest gear.

4.7 Change Positions

On the machine tool the slides may be needed to be sent to a given position during the execution of different functions, such as tool change or palette change. The coordinates of these positions must be measured and written in control.

4.7.1 Setting Change Positions

Three parameter groups are available among **REFPAR** parameters to store change positions: groups **7041 REFPOS2**, **7061 REFPOS3** and **7081 REFPOS4**. The change positions can be written for each axis within one group, i.e. maximum 8 coordinates can be written in each group.

☞ *Warning!* *Parameters of group **7021 REFPOS1** do not serve for change position registering but specifying the position of reference point in machine coordinate system.*

1 Set **reference points** on all axes.
2 Delete all tool and work offsets and use MACHINE POSITION screen for position display.
3 Move the appropriate axis to the desired change position. Enter the positions seen in the machine coordinate system display in input increment (i.e. the value in display without decimal point) at the appropriate parameters 704n **REFPOS2n**, 706n **REFPOS3n** or 708n **REFPOS4n**.

4.7.2 Travel to Change Position

Travel to change position on NC axes is only possible by means of NC commands. Function **G30** is for this purpose, the use of which can be found in Programmer's Manual.
The program language of NCT control enables the **subprogram** call by functions **M, S, T, A, B, C**, (see Programmer's Manual). The control can be informed of this fact in parameter groups **9081 MSUBPRG** and **9121 ABCST** among **MACRO** parameters.
Below two application examples are shown.

Travel to tool change position (before executing M06)

Axis Y must be traveled to change position on horizontal machining center before executing function **M06**. Before Y would head for the change position axis Z is pulled back near to positive limit position for the tool overhang not to hinder movement Y.

1 Change position Y is measured and written at parameter 7042 **REFPOS22**.
2 The positive limit position of axis Z is read at parameter 3003 LIMP13, e.g. 1000 (1mm) is retracted from it and the result is written at parameter 7043 **REFPOS23.**
(Above 4282 Y=2 and 4283 Z=3 is assumed, i.e. Y is the 2nd, Z is the 3rd physical axis in AXIS parameter group among SERVO parameters.)
3 Set parameter 9081 **M(9000)** among MACRO parameters to 6.
This means that any time the control loads code M06 from part program, subprogram No. O9000 is called. If code M06 is loaded in subprogram No. O9000 the subprogram is not called again, but transmits the code to PLC.

4 Write the following program in control:

```
%O9000                  (M06 TOOL CHANGE)
G30  ZI0 P2             (PULL TOOL BACK TO P2 CHANGE POSITION)
G30 YI0 P2              (TRAVEL TO CHANGE POSITION P2 ON AXIS Y)
M9 M19                  (COOLANT OFF, SPINDLE ORIENTATION)
M6                      (TOOL CHANGE)
M99                     (RETURN)
%
```

Palette change

Suppose in the above case palette can also be replaced. There are two change positions along axis X. Palette change is activated by function M60 by calling subprogram No. O9001 (parameter state 9082 **M(9001)**=60). First it travels to the empty position and puts palette on table there than goes for the new palette to the other change position. The position of the 1st change position is written at parameter 7041 **REFPOS21**, while that of the 2nd one is entered at parameter 7061 **REFPOS31**. The subprogram of function M60 implementing palette change is as follows:

```
%O9001(M60 PALETTE Change)
G30 ZI0 P2              (PULL TOOL BACK TO P2 CHANGE POSITION)
G30 YI0 P2              (TRAVEL TO CHANGE POSITION P2 ON AXIS Y)
M113                    (UNCLAMP ROTARY TABLE)
B0                      (ROTATE ROTARY TABLE TO ZERO)
M114                    (CLAMP ROTARY TABLE)
G53                     (SYNCHRONIZATION BECAUSE OF INTERFACE INPUT TEST)
IF[#1014EQ0] GOTO10     (IF 1ST POSITION OCCUPIED)
G30 XI0 P2              (TRAVEL TO 1ST POSITION)
M161                    (PUT PALETTE OUT)
G30 XI0 P3              (TRAVEL TO 2ND POSITION)
GOTO20                  (GOTO BLOCK 20)
N10          G30 XI0 P3 (TRAVEL TO 2ND POSITION)
M161                    (PUT PALETTE OUT)
G30 XI0 P2              (TRAVEL TO 1ST POSITION)
N20          M162       (TAKE PALETTE IN)
M99                     (RETURN)
%
```

4.8 Problems with Rotary Table Operation

The control operates rotary axes similarly to linear axes, i.e. in angle range –99999.999°, +99999.999°, provided increment system B is applied. The only difference is that if one of addresses A, B or C is selected for rotary axis and parameter 0182 A.ROTARY, 0185 B.ROTARY, 0188 C.ROTARY in IPLCONST parameter group is set to 1 no inch/metric conversion is executed for rotary axes as the effect of command G20/G21.
Various special user as well as machine demands may arise regarding rotary axes. Below two examples are shown in order to satisfy these needs. In both examples the address of the rotary axis is B.

4.8.1 Operating rotary table in angle range 0° – +359.999°

1 Select address B for rotary axis by setting parameter 0185 **B.ROTARY** to 1.
2 Enable roll-over operation for axis B by setting parameter 0242 **ROLLOVEN_B** to 1.
3 Set the rotary axis periodicity. Since in our case it is 360° the value of parameter 0262 **ROLLAMNT_B** is 360000 (in input increment unit).
4 Set parameters 0245 **ABSHORT_B** and 0248 **RELROUND_B** as desired.

4.8.2 Operating rotary axis can be positioned to discrete values

The machine is equipped with a rotary table with Hirth toothed rings (axis B) which can be oriented in 1° discrete steps. M113 unclamps the rotary table, while M114 clamps it.
The user demands are as follows:
– the rotary table should always move at rapid traverse rate,
– in case of absolute data input (G90) the table should always move along the shorter path, i.e. its maximum rotation should be 180°,
– in case of incremental data input (G91) the table should always move in the programmed direction, but the movement should not be greater than 359.999°,
– the position should be indicated in angle range 0° – +359.999° after the movement.
For example the table is in position 30°.
As the effect of block G90 B330 the table is rotated with –60° (in negative direction) and +330°is displayed after the movement.
However with command G91 B300 it moves +300° (in positive direction) and +330°is displayed after the movement

1 Select address B for rotary axis by setting parameter 0185 **B.ROTARY** to 1.
2 Enable roll-over operation for axis B by setting parameter 0242 **ROLLOVEN_B** to 1.
3 Set the rotary axis periodicity. Since in our case it is 360° the value of parameter 0262 **ROLLAMNT_B** is 360000 (in input increment unit).
4 Set parameter 0245 **ABSHORT_B** to 1 for the table to move in the shorter direction in case of absolute positioning.
5 Let the value of parameter 0248 **RELROUND_B** be 1, so it can not rotate more than 360°in case of incremental data input.
6 Further demands are to be written in a subprogram. Subprogram call to address B can be organized in the following way: set parameter 9122 **B(9031)** among MACRO parameters to 1.

As the effect of this, if the control loads address B from a block
– subprogram O9031 is called as the effect of address B and the value of address B is transferred to the subprogram through variable #196,
– if other movements, e.g. movements X, Y, Z have also been programmed in the block, movement B, since it is a subprogram call, is executed after movements X, Y, Z,

7 Write the following subprogram in the store:

```
%O9031(ROTATION B)
#101=#4001                    (SAVE INTERPOLATION CODE)
#196=FIX[#196]                (CUT FRACTION OF VALUE WRITTEN AT B, SO THAT
                              ORIENTATION IS TO INTEGER DEGREE VALUE)
M113                          (UNCLAMP ROTARY TABLE)
G0 B#196                      (ROTATE)
M114                          (CLAMP ROTARY TABLE)
G#101                         (RESTORE INTERPOLATION CODE)
M99                           (RETURN)
%
```

4.9 Set-up Procedure of Probe on Milling Machine

1 Connect probe to NCT–TC unit through a connector mounted to a suitable place on the machine. If the probe is an in spindle clampable one **do not place it in the spindle**.
2 Check connections of probe and probe interface unit (chapter 2.11 page 57). Open TEST MES screen (chapter 3.3.5 page 76) and check if the probe signal (PROBE) is connected to the appropriate input with the help of **Tp. trg test** action. Check if 24V outputs –STS and RDY appear in the appropriate interface inputs by means of setting I/O TEST screen (chapter 3.3.3 page 71.).
3 Make sure that the **spindle cannot be started** (M3, M4), if the **probe fixed in spindle** is connected to control. Interface signal **RDY** is for this purpose. When it is set to **1** the **spindle rotation** must be **disabled** in PLC program.
4 Check by means of writing single block: G1 XI10 F100 if the PLC program enables feed rate or requests spindle rotation. If the probe is plugged **PLC program** must set flag **Y650** to **1** independent of the spindle rotation state, in order to move at feed rate.
5 Check if the setting of parameter 8041 **G31BIT** suits the probe connection (see chapter 2.7.5 on page 42.).
6 If NCT macros are used for probe, then set parameter 8063 **SKIPF** to 0, because these macros set feed rate themselves.
7 Write and execute single block *G31 XI20 F50*. Push probe bar during movement. If the movement **does not fulfill** the programmed 20 mm path but **immediately stops** by pressing probe stylus the current settings are correct.
8 If NCT measuring macros are used they request interface inputs at variables #1000 and #1001 (#1000=–STS, #1001=RDY). The inputs to be requested at variables #1000, ..., #1015 are set at parameters. Set parameter 9221 **I_LINE** according to the connection of signals –STS and RDY (chapter 2.11 page 57). If these inputs are connected to I040, I041**,** then 9221 **I_LINE**=4.
9 If NCT measuring macros are used, then fill out parameter group **9041 GMACRO** in the following way:9041 **G(9010)**=101, 9042 **G(9011)**=102, 9043 **G(9012)**=103, ..., 9050 **G(9019)**=110.
10 If the measurement results are to be printed, then set parameter 9143 **PRNT** to 1.
11 If the spindle can be indexed (positioned) and indexing occurs to code M, then set the **code of function M**, as the effect of which the spindle rotates 180 deg incrementally from oriented state (M19) at macro variable **#510**. If the spindle can be indexed at address C set #510=1 and search for block N40 in macro. No. O9011 and write *C180* instead of command *M#510*.
12 Load the following programs in control: O9010, O9011, ..., O9019, O9983, O9984, ..., O9989.

4.10 Set-up Procedure of Tool Offset Sensor on Lathe

1 Check connections of tool offset sensor and interface board (chapter 2.11 page 57). Open TEST MES screen (chapter 3.3.5 page 76) and with the help of **Tp. trg test** action check if signal PROBE changes in the appropriate input by pushing all four side switches of tool sensor separately. Check if –STS output appears in the appropriate 24V interface input by means of opening I/O TEST screen (chapter 3.3.3 page 71).

2 Write the followings in the PLC program:

```
:001
...
...

          /* AUTOMATIC TOOL LENGTH MEASURE */

Y403                    ;if jog mode

 (I426AV426)            ;if auto tool length measure
                        ;button pressed
  Y426                  ;if auto measure mode
          D426          ;end of auto measure mode
          D546          ;module :002 off
  E                     ;else
          U426          ;auto measure mode
          DF0800        ;I027 previous state
          U546          ;module :002 on
  Z                     ;end of condition auto measure mode
 Z                      ;auto tool length measure
                        ;end of condition button pressed

          LRH027        ;screen code
 =.0405                 ;if length offset measure
                        ;on screen
 E                      ;else
          D426          ;end of auto measure mode
          D546          ;module :002 off
          ,0            ;store to 0 OP
          SY58          ;delete flags
 Z                      ;length offset measure
                        ;end of condition

E                       ;else no jog mode
          D426          ;end of auto measure mode
          D546          ;module :002 off
          ,0            ;store to 0 OP
          SY58          ;delete flags

Z                       ;end of condition jog mode
...
...
J1


/* :002 modul */

:002

NLP027                  ;request tool sensor state
SF0801                  ;tool sensor current state

(NF0800                 ;if not pushed previously
AF0801)                 ;and pushed now

 Y430                   ;if jog X+
          U580          ;tool sensor X+ on
```

```
 E                      ;else
          D580          ;tool sensor X+ off
 Z                      ;end of condition jog X+

 Y434                   ;if jog X-
          U581          ;tool sensor X- on
 E                      ;else
          D581          ;tool sensor X- off
 Z                      ;end of condition jog X-

 Y432                   ;if jog Z+
          U582          ;tool sensor Z+ on
 E                      ;else
          D582          ;tool sensor Z+ off
 Z                      ;end of condition jog Z+

 Y436                   ;if jog Z-
          U583          ;tool sensor Z- on
 E                      ;else
          D583          ;tool sensor Z- off
 Z                      ;end of condition jog Z-

Z                       ;end of condition not pressed previously

(F0800                  ;if pressed previously
ANF0801)                ;and not pressed now

          D580          ;tool sensor X+ off
          D581          ;tool sensor X- off
          D582          ;tool sensor Z+ off
          D583          ;tool sensor Z- off

Z                       ;end of condition pressed previously

LF0801                  ;tool sensor current state
SF0800                  ;tool sensor previous state

J2

/* end of module :002 */
```

3 Check if the setting of parameter **G37BIT** No. 8042 suits the tool sensor connection (see chapter 2.7.5 on page 42.).

4 Enter the feed rate, at which the tool is moved as the effect of measure button at parameter **G37FD** No. 8022.

5 Open jog mode by the use of button . Select a tool. Open TOOL LENGTH OFFSET MEASURE screen and an offset group by means of **Offset register search** action.

6 Afterwards select **Automatic measure** action. If the action button pressing is not accepted by the control, then check handling of flags I426, Y426 in PLC program.

7 Touch the appropriate switches of tool sensor with the tool tip by moving with buttons , , , . The control has to stop automatically after running to sensor switch than has to run off by pressing the opposite direction button. If it does not function satisfactorily, then check handling of flags Y580, ..., Y583 in PLC.

8 Measure the positions of tool sensor switches and enter the values at parameters **CONTACTX+** No. 8081, ..., **CONTACTZ–** No. 8084. The tool sensor calibration is discussed in chapter 4.11 on page 112..

4.11 Calibrating Tool Sensor on Lathe

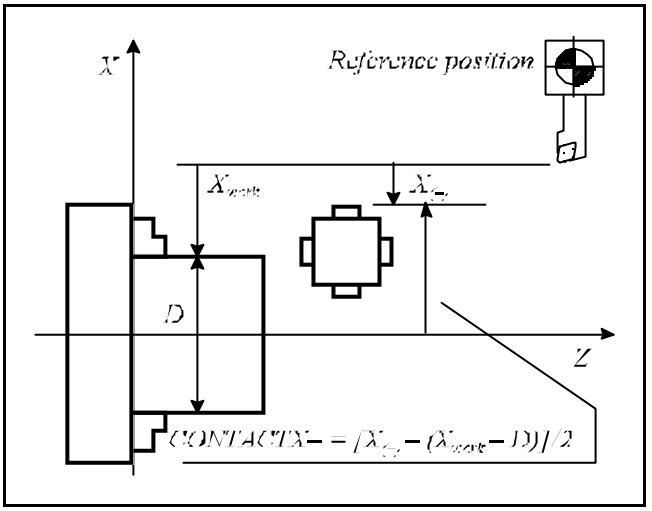
Tool sensor calibration means the specification and storing of button positions at CONTACT parameters. The tool sensor can be calibrated in two ways.
The first choice is to specify the button positions of the tool sensor in a coordinate system established by the user, e.g. in the chuck coordinate system. In this case the length offset values cover the zero position offset according to reference point.
The other choice is to specify the button positions of tool sensor according to the reference point. In this case the length offset values equal to the tool length.

Warning!
Parameters 8081 CONTACTX+ and 8082 CONTACTX– must always be given in ***radius*** *independent of the default interpretation in control being diameter or radius. All CONTACT parameters must be given in the duple of output unit system, thus for example in case of metric machine and INCRSYSTB=1 in μm without decimal point.*
All length offsets, zero position offsets, as well as all CONTACT parameters must be deleted before calibration start.

4.11.1 Calibrating Tool Sensor to Chuck Coordinate System.

Calibration in X direction

Turn an optional work, move from work in direction Z and read **machine position** of axis X indicated with $\mathbf{X_{work}}$ on the diagram. Measure the work diameter indicated with **D** on the diagram.
Execute an automatic tool length measure as discussed in "Operator's Manual" in direction X–. Read value of the selected offset register, indicated with $\mathbf{X_{(-)}}$ on the diagram.. Calculate and enter the value of parameter CONTACTX– on the basis of the following relation:

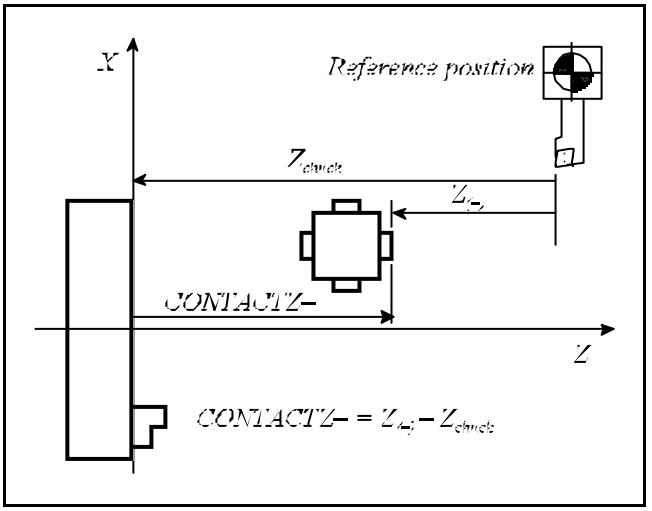


$$CONTACTX- = [X_{(-)} - (X_{work} - D)]/2$$

In the above equation display X is assumed to be in diameter. Position of button in direction X+ can also be defined on the basis of the above procedure.

Calibration in direction Z

Define the position of tool tip according to chuck plane indicated with Z_{chuck} on the diagram.
Execute automatic tool length measure as discussed above in direction Z–. Read the

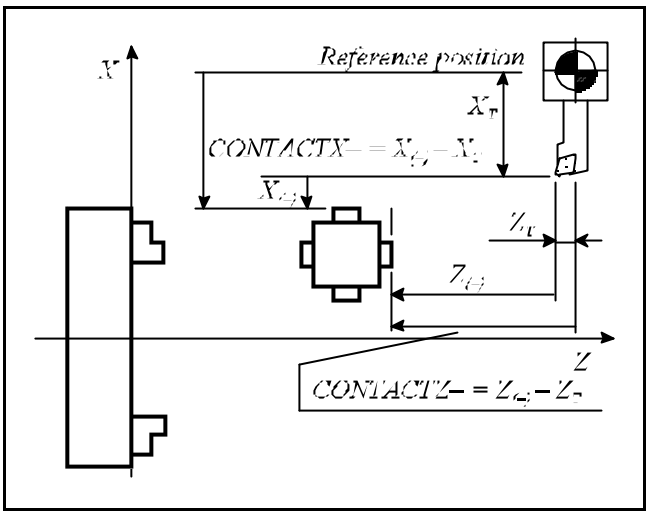


value of the selected offset register Z. The selected Z is indicated with $\mathbf{Z_{(-)}}$ on the diagram. Calculate and enter the value of parameter CONTACTZ– on the basis of the following relation:

CONTACTZ– = $Z_{(-)} - Z_{chuck}$

Position of button in direction Z+ can also be defined on the basis of the above procedure.

4.11.2 Calibrating Tool Sensor to Reference point



Take a look at the following diagram.
Put a tool, the length of which is known, in the tool holder. The tool length is indicated with $\mathbf{X_T}$, $\mathbf{Z_T}$ on the diagram.
Execute automatic tool length measure as discussed above. This is shown in direction X–, Z– on the diagram. Read the value of offset registers X and Z indicated with $\mathbf{X_{(-)}}$, $\mathbf{Z_{(-)}}$ on the diagram. Calculate and enter the value of CONTACT parameters on the basis of the following relations:

CONTACTX– = $X_{(-)} - X_T$

CONTACTZ– = $Z_{(-)} - Z_T$

The procedure can be repeated for the other buttons.

4.12 Other Settings

4.12.1 Operating PLC Constants

The so called PLC constants are 16-bit parameters called directly from PLC program with the help of statement LRP0nn. They are divided into two parts between parameters **0001 CONST** and **0011 CONST2**. The first one is the so called user parameter, thus set also in SETTINGS menu, while the latter one can only be set in SERVICE menu. The PLC programmer must decide upon the constants, the setting of which is to be enabled for the user.
They can be applied for a wide range of usages. E.g.: machine configuration, as well as setting of lubrication duration and of the pause between two lubrications.

4.12.2 Setting Tool Change Parameters

1 If the PLC program applies tool pot table for registering tools, then set length of tool pot table at parameter 0061 **MAGAZIN**.
2 If PLC program applies free-purpose PLC table, then set table length at parameter 0062 **PLC_TAB**.
3 Set parameter 0082 **M06**. If the parameter is 0, tool change occurs as the effect of code T, while if parameter is 1, of code M06. This parameter must be set for the correct execution of block search.

4.12.3 Parametering Free-purpose Analog Outputs

The control enables the transmitting of analog voltage in two optional analog outputs of XMU board from PLC program with the help of flags Y670, ..., Y677 and registers RH080, ..., RH087.

1 Connect and configure XMU board as discussed in chapter 2.8.1 on page 45. The configuration can be set in parameter group **0101 COMMAND**.
2 Set output scaling as well as ramping of signal in parameter groups **0121 ANALOG1** and **0141 ANALOG2**.

4.12.4 Setting Path Dependent Lubrication

The path, after which a lubrication cycle may start can be set at parameter 016n **LUBCONSTn** (n=1, ..., 8 is the axis number). After the given path is done the control sets flag I57n to 1 for one PLC cycle.

4.12.5 Function Transfer at Addresses A, B, C

The NC can transfer functions to PLC at address A, B or C with the help of input flags I527, I530, I531 and registers RH007, RH008, RH009. In order to transmit the address written in part program as function, the appropriate parameter 0183 **A.MISCEL**,0185 **B.MISCEL** or 0189 **C. MISCEL** must be set to 1.
For example if an index table, the rotational axis of which is parallel to axis Y and the table is not moved with servo, address B may be selected for function. It can also be used for defining analog output values.

4.12.6 Screen Settings

1 The **language** to be used can be set in parameter group **0501 LANGUAGE**.
2 Two possibilities are offered for screen **coloring**. If setting 0521 **USERCOLOR**=0 is applied the control uses the built-in default color set for color setting independent of other parameter

settings of parameter group **0521 COLORV**. Parameter 0522 **BORDER** makes an exception, for the frame color can be specified even in this case. Advised value: 7.

3 If setting 0521 **USERCOLOR**=1 is applied, all elements of parameter group **0521 COLORV** must be filled out .

4 During **graphic** tool path display the tool tip location is shown by a little **cross** on screen. The cross is only drawn on screen if 0562 **CROSS ON**=1. The cross size can be set at parameter 0561 **CROSS DOT**. Its value range: 0...7.

5 In order to increase the screen life it is expedient to set **screen saver**. In this case screen saving means the progressive decreasing of brightness. If 0564 **SCREEN SAVER**=0 there is no screen saver. If 0564 **SCREEN SAVER**>0 the number written at the parameter indicates the starting time of screen saver as to the last button push in minute. The shade, till which the screen is darkening can be set at parameter 0565 **SHADING**. If the control sends error message the screen switches to the maximum bightness and the shading cycle is restarted.

6 Program listing on PROGRAM LIST screen can be determined with the help of parameters 0566 **DNC LINES** and 0584 **DSP LST**.

7 It is possible to number the blocks automatically in the course of program editing. If 0567 **N STEP**=0 the numbering is off, if 0567 **N STEP**>0 the control automatically increments address N with the number written at the parameter after going to each new block.

4.12.7 Parameters Influencing Axis Movements

1 The feed rate can be increased in the course of machining, provided rapid traverse rate button is pressed. The feed rate increases so many times written at parameter 1371 **FMULT**.

2 If 1372 **JOGFEED**=0 in case of using jog buttons (, , ect.) the feed rate is the modal feed rate in mm/min. If the parameter is 1 (which is advised) the feed rates are registered from table (see parameter 1372 JOGFEED) according to the feed rate override switch state.

3 In the course of counting handwheel pulses the control optionally moves the axis till the handwheel is turned (pulses are not buffered), or moves all increments the value can be seen engraved on handle (pulses are buffered). The option can be selected by means of parameter 1373 **HNDLFEED**. In case of slow machine, where the rapid traverse rate is low, the advised setting is 1373 **HNDLFEED**=1 (not buffered).

4 The minimum value of rapid traverse override switch can be set at parameter 1204 **RAPOVER**. Advised value: 1...5%.

5 The value of parameter 1241 **POSCHECK** defines, if it executes position check after rapid traverse movement, or not (follow error <**4261 INPOS**).

4.12.8 Settings of Initializing after Power-on and Reset

1 The default feed rate F in effect **after power-on** can be specified in mm/min at parameter 1061 **FEED**. If feed rate per revolution is programmed after power-on without specifying value F, the control moves at FEED/10 mm/rev.

2 The default constant surface speed **after power-on** can be specified at parameter 1081 **CTSURFSP**, as well as the axis concerned at parameter 1082 **CSAXIS**.

3 The start-up code G in effect **after power-on**, as well as the state after overall **resetting of automatic mode** provided parameter 1243 **CLEAR** is 1 can be specified in parameter group **1221 CODES**. The common value of 1222 **G17 G18** as well as of 1226 **G94 G95** is 0 in

milling control, and 1 in lathe control. Set parameter 1227 **MULBUF** to 1.

4.12.9 Different Parameters Influencing Part Programming

These parameters can be found in COMMON and MACRO parameter groups. Take the setting of each one into consideration after reading the description of parameters. Below some parameters influencing the execution of part program are outlined.

1 In the course of circle interpolation the control really interpolates a spiral with constantly varying radius. The difference between the start position radius and the end position radius of circle can be set at parameter 1021 **RADDIF**.

2 The circle interpolation (G02, G03) description in Programmer's Manual contains, that if the circle center is specified at addresses I, J, K, these values are always incremental, measured to circle center: **the common and advised setting is 1246 CCABS=0**. If 1246 **CCABS**=1, then addresses I, J, K are always interpreted as absolute values.

3 In case of applying user macros G M S T A B C the state of parameter 9126 **FGMAC** influences program execution.

4 The execution rate of macro blocks is influenced by parameter 9161 **SBSTM**.

5 PARAMETERS

5.1 Introduction

The parameters render the particular variables of the control accessible to the user, through which the control system can be adapted to the needs of the machine tool and the peripherals connected to it.
The parameters are described below in the order of their applications in the control. If you know the name of a parameter, you can go immediately to the appropriate page with the help of the *Alphabetical Index*.

The control includes the following ten groups of parameters:

0001	**IPLCONST**	(PLC constants)
0501	**DISPLAY**	(parameters for screen setting)
1001	**COMMON**	(general-purpose common parameters)
2001	**SERIAL**	(Serial interface parameters, RS- 232C transfer)
3001	**AX.LIMIT**	(parameters of stored stroke limit)
4001	**SERVO**	(Servo parameters)
5001	**SPINDLE**	(spindle control parameters)
6001	**PTCHCMP**	(parameters of pitch error compensation)
7001	**REFPAR**	(reference point return parameters)
8001	**MEASURE**	(probe parameters)
9001	**MACRO**	(parameters of user macro)

The groups include the particular parameters associated with each function of the control.

From the point of view of the access competence there are two kinds of parameters:
– user's parameters and
– system parameters.
User's parameters can be overwritten on USER'S PARAMETERS screen of SETTINGS screens without giving any password.
System parameters together with user parameters can be overwritten only on PARAMETERS screen of SERVICE screens, after the overwriting is enabled (see chapter 3.3.1 on page 67). The overwrite enable can be executed on SECURITY PANEL screen of SETTINGS screens (see chapter 3.4 on page 80).
The user parameters are indicated among system parameters (SERVICE screens) with symbol ☜.

5.1.1 Valid Data Ranges of Parameters

The valid data range of a parameter can be given in the brackets following the parameters and subgroups. The types are explained in the table below;

Data Type	Data Length (byte)	Valid Data Range
BIT	c	0, 1
BYTE	1	0..255
SHORTINT	1	–128..127
WORD	2	0..65535
INTEGER	2	–32768..32767
DWORD	4	0..4294967295*
LONGINT	4	–2147483648..2147483647**

Values to parameters of a given type can be given with the numbers specified in the valid data range. In a specific case, the valid range may be narrowed further in accordance with the interpretation of the parameter.

☞ *Warning!*

The values to be entered at the parameters can only be integers, no reference can be made to fractions. If necessary the measure unit, in which the parameter is interpreted must be indicated. Below some terms used in the manual are elicited.

5.1.2 Reference to Coordinate Data

Since no fraction can be entered at the parameters the coordinate data referring to the axes must be given in either input or output increment. Whether the control interprets the appropriate parameter in input or output increment is shown beside the parameters here.

Input increment

The control interprets the input increment of parameters on the basis of parameters INCH DET, INCRSYSTA, INCRSYSTB and INCRSYSTC. In the below table the meaning of 1 input increment can be read in case of linear axes.

*only numbers in the range of 0..999999999 can be written in the parameter editor.

**only numbers in the range of ±999999999 can be written in the parameter editor.

The meaning of 1 input increment in case of linear axis

in case of linear axis	INCRSYSTA=1	INCRSYSTB=1	INCRSYSTC=1
INCH DET=0	0.01 mm	0.001 mm	0.0001 mm
INCH DET=1	0.001 inch	0.0001 inch	0.00001 inch

The appropriate (A, B or C) axis can be selected for rotary axis at parameters A.ROTARY, B.ROTARY, C.ROTARY. The meaning of 1 input increment in case of rotary axis:

The meaning of 1 input increment in case of rotary axis

in case of rotary axis	INCRSYSTA=1	INCRSYSTB=1	INCRSYSTC=1
	0.01 deg	0.001 deg	0.0001 deg

Output increment

The output increment is always half of the input increment. In the course of position measure and servo circuit handling the control always works with output increment. Certain parameters must be given in output increment. The control interprets the output increment of parameters on the basis of parameters INCH DET, INCRSYSTA, INCRSYSTB and INCRSYSTC. In the below table the meaning of 1 output increment can be read in case of linear axis:

The meaning of 1 output increment in case of linear axis

in case of linear axis	INCRSYSTA=1	INCRSYSTB=1	INCRSYSTC=1
INCH DET=0	0.005 mm	0.0005 mm	0.00005 mm
INCH DET=1	0.0005 inch	0.00005 inch	0.00005 inch

The appropriate (A, B or C) axis can be selected for rotary axis at parameters A.ROTARY, B.ROTARY, C.ROTARY. The meaning of 1 output increment in case of rotary axis:

The meaning of 1 output increment in case of rotary axis

in case of rotary axis	INCRSYSTA=1	INCRSYSTB=1	INCRSYSTC=1
	0.005 deg	0.0005 deg	0.00005 deg

5.1.3 Reference to Feedrate and Acceleration Data

In case of entering at parameters the measure unit cannot be less than 1mm/min, 1inch/min, or 1 deg/min. The measure unit of feedrate and acceleration values entered is defined at parameter INCH

DET in case of linear axis. The table below shows the interpretation of feedrate and acceleration data:

The meaning of 1 feedrate and acceleration unit in case of linear axis

INCH DET	feedrate	acceleration
0	1 mm/min	1 mm/sec^2
1	1 inch/min	1 inch/sec^2

The appropriate (A, B or C) axis can be selected for rotary axis at parameters A.ROTARY, B.ROTARY, C.ROTARY. The table below shows the interpretation of feedrate and acceleration data:

The meaning of 1 feedrate and acceleration unit in case of rotary axis

feedrate	acceleration
1 deg/min	1 deg/sec^2

5.2 IPLCONST Parameter Group

***0001 CONST** subgroup (WORD)*

00nn **CONSTnn** (WORD), nn=1..10

***0011 CONST2** subgroup (WORD)*

00nn **CONSTnn** (WORD), nn=11..40

Parameter transfer to the PLC. 40 freely available parameters loaded from the PLC program by means of statement LRP0nn. The ones in CONST subgroup are user parameters and the ones in CONST2 subgroup are system parameters. The storage of data in either user or system parameters is decided by the PLC programmer.

***0061 PLC_TAB** subgroup (BYTE)*

0061 **MAGAZIN** (BYTE)

Length of tool pot table. At parameter MAGAZINE the number of free places of the magazine (tool storage), i.e. of tool pots is to be written. Line No. 0 of the table shows the code of the tool in the spindle, i.e. the spindle is pot No. 0.
The tool pot table can be found among the SETTING screens under the caption TOOL POT TABLE, and can be filled in from the operator's panel. The PLC program can also write in or read the table at addresses F5nn.

0062 **PLC_TAB** (BYTE)

Length of the freely available table of the PLC program. The PLC table can be found among the SETTING screens under the caption PLC TABLE. The PLC program can also write in or read the table at address F5nn.

***0081 TOOLCHNG** subgroup (BIT)*

0081 **NODEC** (BIT)

Its value is obligatorily 0.

0082 **M06** (BIT)

1: the tool is replaced as a result of command M06. In order to execute block search correctly, the parameter must indicate, whether the tool change occurs due to command M6 (value of parameter=1) or to command T (value of parameter=0).
In case the value of parameter is 0 the tool number to be activated (T) is gathered in the course of block search.
If the value of parameter is 1, then two tool numbers (T) and one M06 is gathered in the course of block search: T(to be changed) M06 T(to be searched for). As a result of Start key the first tool is searched in the magazine, M06 is executed, that is the tool is changed and the preparation of the next tool is started to the tool number (T) gathered the second time.

0083 **BIDIR** (BIT)

Not used.

0084 **FIX** (BIT)
Not used.

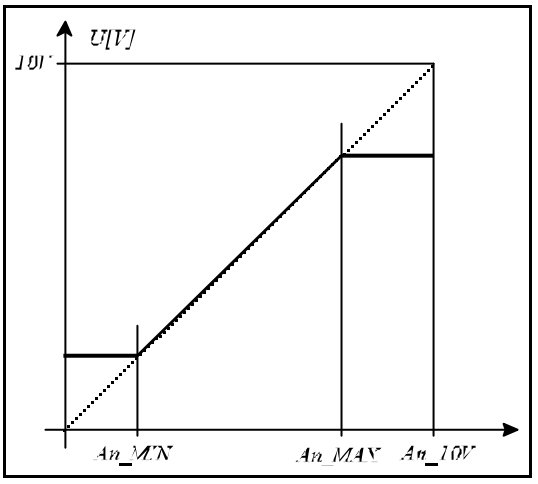
***0101 COMMAND** subgroup (BYTE)*

0101 **COMMAND1** (*BYTE*)
Here the number of the axis, to which the analog output command signal is to be transferred from the PLC through register RH080, or RH081 must be written. The value limit of parameter is 1 ... 12. The number of inputs and outputs of XMU interface board No. 1 (axis number) is 1 ... 4, of XMU No. 2 is 5 ... 8, of XMU No. 3 is 9 ...12. The output can be configured to any board.

0102 **COMMAND2** (*BYTE*)
Here the number of the axis, to which the analog output command signal is to be transferred from the PLC through register RH085, or RH086 must be written. The value limit of parameter is 1 ... 12. The number of inputs and outputs of XMU interface board No. 1 (axis number) is 1 ... 4, of XMU No. 2 is 5 ... 8, of XMU No. 3 is 9 ...12. The output can be configured to any board.

***0121 ANALOG1** subgroup (WORD)*

0121 **A1 10V** (WORD)
Calibration value referring to 10V of the first analog output. If the PLC writes this value into register RH080 the output voltage is 10V.



0122 **A1 MIN** (WORD)
The minimum transferable value in the first analog output. If the PLC writes a value into register RH080 less than the one written in the voltage of the output will be clamped to the value of the parameter and will not go under the value.

0123 **A1 MAX** (WORD)
The maximum transferable value in the first analog output. If the PLC writes a value into register RH080 greater than the one written in the voltage of the output will be clamped to the value of the parameter and will not go above the value.

0124 **A1 ACC** (WORD)
The ramping-up rate of the first analog output when increasing output.
If the value of parameter is 0, the voltage corresponding to the value entered into register RH080 appears in the output immediately.
If the value of parameter >0, the ramping rate of the first analog output is A1 ACC/20msec.

0125 **A1 DCC** (WORD)
The ramping-down rate of the first analog output when decreasing output.
If the value of parameter is 0, the voltage corresponding to the value entered into register RH080 appears in the output immediately.

If the value of parameter >0, the ramping rate of the first analog output is A1 DCC/20msec.

0141 ANALOG2 subgroup (WORD)

0141 **A2 10V** (WORD)

Calibration value referring to 10V of the second analog output. If the PLC writes this value into register RH085 the output voltage is 10V.

0142 **A2 MIN** (WORD)

The minimum transferable value in the second analog output. If the PLC writes a value into register RH085 less than the one written in the voltage of the output will be clamped to the value of the parameter and will not go under the value.

0143 **A2 MAX** (WORD)

The maximum transferable value in the second analog output. If the PLC writes a value into register RH085 greater than the one written in the voltage of the output will be clamped to the value of the parameter and will not go above the value.

0144 **A2 ACC** (WORD)

The ramping-up rate of the first analog output when increasing output.
If the value of parameter is 0, the voltage corresponding to the value entered into register RH085 appears in the output immediately.
If the value of parameter >0, the ramping rate of the second analog output is A1 ACC/20msec.

0145 **A2 DCC** (WORD)

The ramping rate of the first analog output when decreasing output.
If the value of parameter is 0, the voltage corresponding to the value entered into register RH085 appears in the output immediately.
If the value of parameter >0, the ramping rate of the second analog output transfer is A2 DCC/20msec.

0161 LUBCONST subgroup (DWORD)

016n **LUBCONSTn** (DWORD) n=1...8

Parameter of the path dependent lubrication. Index n refers to the axis number. If the appropriate axis has finished the distance written into the parameter (the distance is in input increment) the NC sets flag I57(n-1) for 1 PLC time slice to 1.

0181 ABC subgroup (BIT)

0181 **A.LINEAR** (BIT)

If the axis belonging to address A is linear (its position is given in linear measure) this parameter must be set to 1. In this case the inch/metric conversion is valid for loading as well as displaying this address.

0182 **A.ROTARY** (BIT)

If the axis belonging to address A is a rotary axis (its position is given in deg) this parameter must be set to 1. In this case the inch/metric conversion is not valid for loading as well as displaying this address, but roll-over operation can be enabled by setting parameter 0241 ROLLOVEN_A to 1.

0183 **A.MISCEL** (BIT)

If the value written into address A is to be sent to the PLC through register RH007 this parameter must be set to 1.

0184 **B.LINEAR** (BIT)

If the axis belonging to address B is linear (its position is given in linear measure) this parameter must be set to 1. In this case the inch/metric conversion is valid for loading as well as displaying this address.

0185 **B.ROTARY** (BIT)

If the axis belonging to address B is a rotary axis (its position is given in deg) this parameter must be set to 1. In this case the inch/metric conversion is not valid for loading as well as displaying this address, but roll-over operation can be enabled by setting parameter 0242 ROLLOVEN_B to 1.

0186 **B.MISCEL** (BIT)

If the value written into address B is to be sent to the PLC through register RH008 this parameter must be set to 1.

0187 **C.LINEAR** (BIT)

If the axis belonging to address C is linear (its position is given in linear measure) this parameter must be set to 1. In this case the inch/metric conversion is valid for loading as well as displaying this address.

0188 **C.ROTARY** (BIT)

If the axis belonging to address C is a rotary axis (its position is given in deg) this parameter must be set to 1. In this case the inch/metric conversion is not valid for loading as well as displaying this address, but roll-over operation can be enabled by setting parameter 0243 ROLLOVEN_C to 1.

0189 **C.MISCEL** (BIT)

If the value written into address C is to be sent to the PLC through register RH009 this parameter must be set to 1.

***0201 UVW** subgroup (BIT)*

0201 **U.PARALL** (BIT)

If axis U is parallel to axis X and is to be used by means of plane selecting command G17, or G18 or is to be activated as drilling axis with G19 this parameter must be set to 1.
E.g.: G18 G2 U100 Z250 R300 interpolates a circle in plane ZU.

0202 **U.MACRO** (BIT)

Not used.

0203 **V.PARALL** (BIT)

If axis V is parallel to axis Y and is to be used by means of plane selecting command G17, or G19 or is to be activated as drilling axis with G18 this parameter must be set to 1.
E.g.: G17 G2 X100 V250 R300 interpolates a circle in plane XV.

0204 **V.MACRO** (BIT)

Not used.

0205 **W.PARALL** (BIT)

If axis W is parallel to axis Z and is to be used by means of plane selecting command G18, or G19 or is to be activated as drilling axis with G17 this parameter must be set to 1.

E.g.: in case of G17 G81 X100 Y0 R5 W-250 drills parallel to axis W.

0206 **W.MACRO** (BIT)

Not used.

***0221 MSUPPR** subgroup (WORD)*

022n **MSUPPRn** (WORD), n=1..8

Definition of the M codes suppressing the block preprocession, i.e. the block preprocession is broken till the execution of the code.

***0241 ROLLOVEN** subgroup (BIT)*

0241 **ROLLOVEN_A** (BIT)
0242 **ROLLOVEN_B** (BIT)
0243 **ROLLOVEN_C** (BIT)

If axis A, B or C has been selected for rotary axis at the appropriate parameter 0182 A.ROTARY, 0185 B.ROTARY or 0188 C.ROTARY, roll-over operation may be enabled. Roll-over operation means, that the position on the given axis is registered not between + and – infinite, but by taking the axis periodicity into account, e.g. between 0˚ and 360˚. If the appropriate ROLLOVEN_x parameter

=0: the rotary axis is operated as the linear ones, no roll-over operation is executed and setting of further parameters is ineffective,

=1: roll-over operation is executed on rotary axes.

0244 **ABSHORT_A** (BIT)
0245 **ABSHORT_B** (BIT)
0246 **ABSHORT_C** (BIT)

If roll-over operation is enabled for rotary axis (ROLLOVEN_x=1), in case of absolute data input the axis never moves more than the amount set at the appropriate ROLLAMNT_x parameter. That is, if e.g.: ROLLAMNT_C=360000 (360˚), the greatest amount of move is 359.999°.

The movement direction to occur always according to the sign of the position specified at the axis address or in the shorter path can be set at parameters 0244 ABSHORT_A, 0245 ABSHORT_B and 0246 ABSHORT_C. If the appropriate ABSHORT_x parameter

– =0: it always moves in direction of the sign of the programmed position , if
– =1: it always moves in the shorter direction.

0188 **C.ROTARY**=1, 0243 **ROLLOVEN_C**=1 0263 **ROLLAMNT_C**= =360000	Block programmed with absolute coordinate input	Offset as the effect of the block	Position at the end of block
0246 **ABSHORT_C**=0 it always moves in direction of the sign programmed at address C			C=0
	G90 C450	90	C=90
	G90 C0 (**0 is a positive number!**)	270	C=0
	G90 C–90	–90	C=270
	G90 C–360	–270	C=0
0246 **ABSHORT_C**=1 it always moves along the shorter path			C=0
	G90 C450	90	C=90
	G90 C0	–90	C=0
	G90 C–90	–90	C=270
	G90 C–360	90	C=0

0247 **RELROUND_A** (BIT)
0248 **RELROUND_B** (BIT)
0249 **RELROUND_C** (BIT)

In case of programming incremental data input the direction of the movement is always according to the programmed sign.
The appropriate ROLLAMNT_x parameter to be applied for the incremental movement amount can be set for axes A, B and C at parameters 0247 RELROUND_A, 0248 RELROUND_B and 0249 RELROUND_C, respectively. If the appropriate RELROUND_x parameter:

– =0: parameter ROLLAMNT_x is not applied, thus the movement can be greater than 360˚,
– =1: parameter ROLLAMNT_x is applied. If e.g.: ROLLAMNT_C=360000 (360˚), the greatest amount of move may be 359.999° on axis C.

0188 **C.ROTARY**=1, 0243 **ROLLOVEN_C**=1 0263 **ROLLAMNT_C**= =360000	Block programmed with incremental coordinate input	Offset as the effect of the block	Position at the end of block
0249 **RELROUND_C**=0 parameter ROLLAMNT_C is not applied			C=0
	G91 C450	450	C=90
	G91 C0	0	C=90
	G91 C–90	–90	C=0
	G91 C–360	–360	C=0
0249 **RELROUND_C**=1 parameter ROLLAMNT_C is applied			C=0
	G91 C450	90	C=90
	G91 C0	0	C=90
	G91 C–90	–90	C=0
	G91 C–360	0	C=0

0261 ROLLAMNT subgroup (DWORD)

0261 **ROLLAMNT_A** (DWORD)
0262 **ROLLAMNT_B** (DWORD)
0263 **ROLLAMNT_C** (DWORD)

The amount of movement of one turn on a rotary axis is specified for axis A, B and C at parameters 0261 ROLLAMNT_A 0262 ROLLAMNT_B and 0263 ROLLAMNT_C, respectively, in input increments. Thus, if the control operates in increment system B and moves 360° for one rotation, the value to be written at the appropriate ROLLAMNT parameter is 360000.

In case of the above parameter settings the control always displays the position of the rotating axis in the range of 0°... +359.999°, independent of the direction and the number of axis rotations.

5.3 DISPLAY Parameter Group

***0501 LANGUAGE** subgroup (BIT)*

0501 **ENGLISH** (BIT)
1: displays in English.
0502 **GERMAN** (BIT)
1: displays in German.
0503 **HUNGARIAN** (BIT)
1: displays in Hungarian.
0504 **LANGUAGE 4** (BIT)
1: display in an optional language. Text of the 4th language must be loaded into the control separately.

☞ *Note*: Naturally of the parameters of **LANGUAGE** subgroup only one can be set to 1.

***0521 COLORV** subgroup (**2** BYTE)*

0521 **USERCOLORE** (2 BYTE)
User color settings can be initiated with value other than 0.
0522 **BORDER** (2 BYTE)
Color of the border of the screen.
0523 **PAPER** (2 BYTE)
General paper color.
0524 **INK** (2 BYTE)
General pen color.
0525 **SFPAPER** (2 BYTE)
Background color of menu SOFTKEY.
0526 **SFOPER** (2 BYTE)
Background color of action SOFTKEY.
0627 **SFINKON** (2 BYTE)
Color of the caption of the active SOFTKEY.
0528 **SFINKOFF** (2 BYTE)
Color of the caption of the inactive SOFTKEY.
0529 **SFFRAME1** (2 BYTE)
Left and upper shading of the inactive SOFTKEY.
0530 **SFFRAME2** (2 BYTE)
Right and bottom shading of the inactive SOFTKEY.
0531 **SFFRAMEC** (2 BYTE)
Color of SOFTKEY frame.
0532 **SFFRAMEA** (2 BYTE)
Not used.
0533 **ARROW** (2 BYTE)
Color of directory and other arrows.
0534 **PRGNAME** (2 BYTE)

Color of the display of subroutine levels.

0535 **LISTINK** (2 BYTE)

Pen color of program list.

0536 **LISTPAPER** (2 BYTE)

Background color of program list.

0537 **COMMINK** (2 BYTE)

Pen color of notes, expressions in the program list.

0538 **COMMPAPER** (2 BYTE)

Background color of notes, expressions in the program list.

0539 **SUBINK** (2 BYTE)

Color of the display of subroutine levels.

0540 **REPINK** (2 BYTE)

Color of the repetition number of subroutine levels.

0541 **ABSPAPER** (2 BYTE)

Background color of absolute position display.

0542 **RELPAPER** (2 BYTE)

Background color of relative position display.

0543 **MACPAPER** (2 BYTE)

Background color of machine position display.

0544 **ENDPAPER** (2 BYTE)

Background color of end position display.

0545 **EPAPER** (2 BYTE)

General paper color of the editor.

0546 **EINK** (2 BYTE)

General pen color of the editor.

0547 **EFPAPER** (2 BYTE)

Paper color of the highlighting bar of the editor.

0548 **EFINK** (2 BYTE)

Pen color of the highlighting bar of the editor.

0549 **EEPAPER** (2 BYTE)

Paper color of error message of the editor.

0550 **EEINK** (2 BYTE)

Pen color of error message of the editor

0551 **TESTPAPER** (2 BYTE)

Background color of graphic position display.

0552 **ZOOMINK** (2 BYTE)

Color of ZOOM frame.

Color Code	Color
0	Black
1	Dark Blue
2	Dark Green
3	Dark Cyanide
4	Red
5	Dark Purple
6	Orange
7	Bright Grey
8	Dark Grey
9	Blue
10	Green
11	Gentian
12	Red
13	Yellow
14	Bright Purple
15	White

***0561 GRAPHICS** subgroup (BYTE)*

0561 **CROSS DOT** (BYTE)

In case of graphic tool path drawing (Graphics, DRAW screen) the size of the cross signaling the current position of tool. Its value limit is 0-7.

0562 **CROSS ON** (BYTE)

In case of graphic tool path drawing (Graphics, DRAW screen) the cross signaling the current position of tool is not displayed, if parameter is set to 0, and is displayed if parameter is set to 1.

0563 **FRAME STEP** (BYTE)

Not used.

0564 **SCREEN SAVER** (BYTE)

If the value of parameter =0, the screen saver is inactive. If the value of parameter >0 it shows the time in minutes since the last touch of NC keyboard after which the screen saver is activated.

0565 **SHADING** (BYTE)

The value of parameter determines the level of shading of the intensity after the screen saver had been started. In order to shade the color from white to black the level must be 63.

0566 **DNC LINES** (BYTE)
Number of program lines listed in DNC mode.
0567 **N STEP** (BYTE)
If the value of parameter > 0 the part program blocks are numbered automatically in the course of program editing. The increment of numbering must be entered to the above parameter. If e.g. the value of parameter is 5 the block numbers in order are: N5, N10, N15, N20, ...

0581 DSPX subgroup (BYTE)

0581 **DSP HI** (BIT)
0582 **DSP PUF** (BIT)
0583 **DSP END** (BIT)
Not used.
0584 **DSP LST** (BIT)
It specifies program listing.
0: the program list is only scrolled if the highlighted program line has reached the bottom of screen,
1: the program list is scrolled after block execution.
0585 **DSP FLO** (BIT)
0586 **DSP DIF** (BIT)
Not used.

0601 ROTATION subgroup (WORD)

0601 **HORIZONTAL** (WORD)
The default setting of horizontal rotation of coordinate system when choosing 3D graphic display, and when the Rotation angle is (H)=0 on the GRAPHIC SETTINGS screen. Every rotation is started from this setting.
0602 **VERTICAL** (WORD)
The default setting of vertical l rotation of coordinate system when choosing 3D graphic display, and when the Rotation angle is (V)=0 on the GRAPHIC SETTINGS screen. Every rotation is started from this setting.

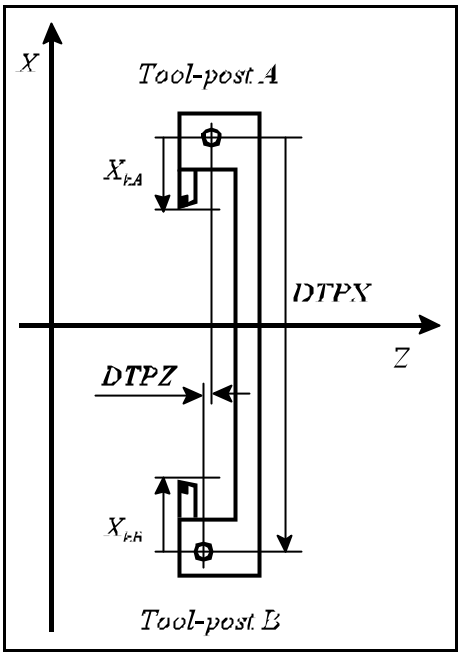
5.4 COMMON Parameter Group

1001 DTP** subgroup (LONGINT)* ***Used only in lathe version

1001 **DTPX** (LONGINT)

In case of programming command G68 (mirror image for double turret on) on lathe-control the distance between the two tool posts needs to be written at this parameter. In the course of mirror image the control uses this offset along axis X. This parameter is applied if tool length offset is measured by means of external devices, i.e. if tool length equals to the tool overhang. It is a number with sign, shows the distance of tool post "B" as referred to "A" on the diagram. In this case the work offset must be measured to tool post "A". It is a value always given in radius.

If the value of tool compensation is measured like work offset, its value is 0.

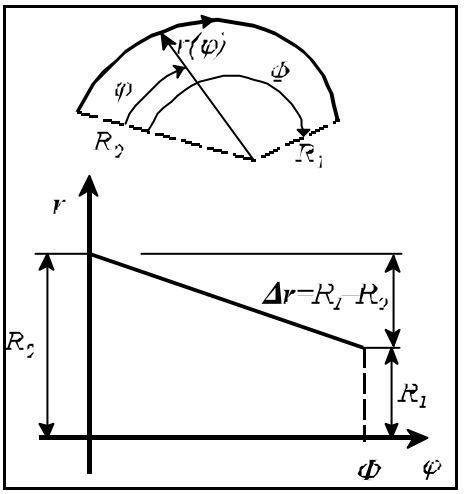


1002 **DTPZ** (LONGINT)

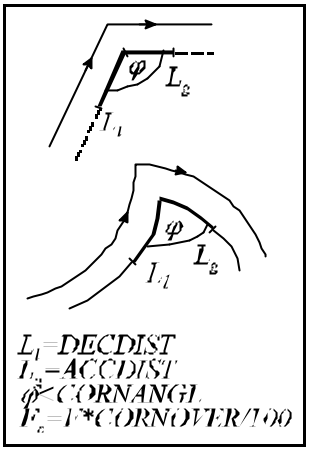
In case of applying command G68 and measuring tool by means of external device the Z-direction-distance of the two tool posts needs to be written here.

***1021 RADDIF** (DWORD)*

Maximum difference between the circle radius in the start (R_0) and end (R_1) position of arc. If the difference is less than the value given at this parameter ($\Delta r<RADDIF$) a circle with varying radius is interpolated, if larger error message ($\Delta r>RADDIF$) RADIUS DIFFERENCE No. 3011 is sent.



*1041 **DISTANCE** subgroup (DWORD)*



1041 **DECDIST** (DWORD)

When machining internal corners in switched-on state of G62 and tool radius offset calculation (G41, G42), the corner override function will be effectuated within distance DECDIST before the corner. The control interprets the value written at parameter DECDIST in input increment system.

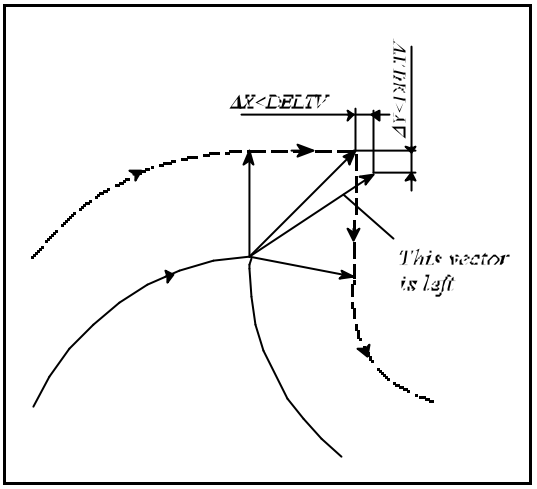
1042 **ACCDIST** (DWORD)

When machining internal corners in switched-on state of G62 and tool radius offset calculation (G41, G42), the corner override function will be effectuated up to distance ACCDIST after the corner. The control interprets the value written at parameter ACCDIST in input increment system.

☞ *Note*: see also subgroup **OVERRIDE**!

1043 **DELTV** (DWORD)

When bypassing sharp corners in switched-on state of tool radius offset calculation (G41, G42), provided the displacement is in case of both axes shorter than the value written at DELTV along each of the vertical and horizontal axes, the resultant displacement will be joined up to the next one. The control interprets the value written at parameter DELTV in input increment system.



***1061 FEED** (WORD)*

Default feed rate, generated by control at address F after power-on.

***1081 CTSURFSP** subgroup (WORD)*

1081 ***CTSURFSP** (WORD)*

Default surface speed. At the time of power-on it is taken into account by the control. Its measure unit is m/min if parameter 4763 INCH DET is 0 and feet/min if parameter 4763 INCH DET is 1.

1082 **CSPAXIS** (WORD)

The number of the axis, in case of which constant surface speed calculation is to be validated. On the basis of the value written at the parameter it is validated to the following axes: =1: X, =2: Y, =3: Z, =4: U, =5: V, =6: W, =7: A, =8: B, =9: C

1101 BCKLSH subgroup (INTEGER)

110n **BCKLSHn** (INTEGER), n=1..8

Compensation for backlash error.

If, because of mechanical imperfections of the machine tool, the axis covers a distance longer or shorter than the command distance in a direction reversal, the difference can be reduced with a compensation value written at this parameter. The control interprets the value written at the parameter in input increment system.

1121 KEYBOARD subgroup (BYTE)

1121 **TYPEMATIC** (BYTE)

Except for the jog buttons, buttons and keys of the control are of repeating type. This means that

- SQ the effect of a depressed button/key will be immediate;
- SQ with the button/key contiuously held down its effect will come into operation again after a programmed delay (Typematic Delay);
- SQ with the button/key continuously held down the appropriate code will be entered again and again with a programmed frequency (Typematic Rate) in the CPU of the control.

The delay (TD) and the frequency (TR) can be set with the TYPEMATIC parameter. Their recommended value is 63. The values of delay (TD) and frequency (TR) can be calculated in the following way:

$$TR=\frac{[D4..D0]}{3}*100ms \quad , \quad TD=([D6..D5]*2)+4*100ms \quad ,$$

where: TR=typematic rate,
TD=typematic delay,
Dn= the n^{th} bit of parameter TYPEMATIC.

1122 **JOGX+** (BYTE)

Not used.

1123 **JOGX–** (BYTE)

Not used.

1124 **JOGY+** (BYTE)

Not used.

1125 **JOGY–** (BYTE)

Not used.

1126 **JOGZ+** (BYTE)

Not used.

1127 **JOGZ–** (BYTE)

Not used.

1128 **JOG+** (BYTE)

Not used.

1129 **JOG–** (BYTE)

Not used.

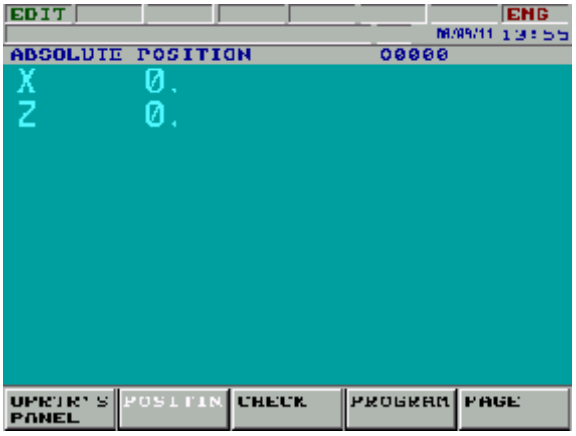
1130 **SFNUMB** (BYTE)

Number of softkeys to be drawn on screen. Its values can be:

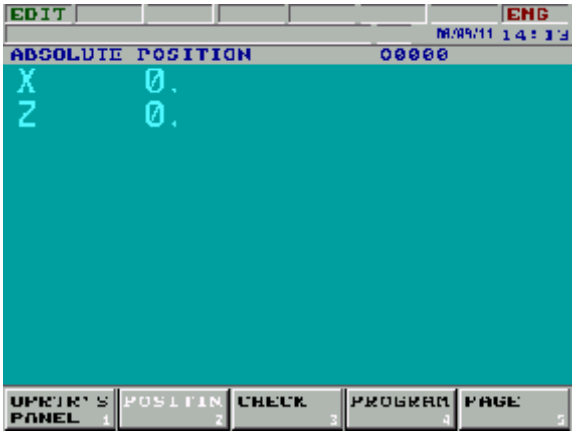
4, 5, 8, 10, 14, 15, 16, 18, 20

If its value is **4, 5, 8, 10**, then the appropriate number of softkeys is drawn on screen and the **bottom right corner** of the softkeys **is empty**.

If its value is **14, 15, 18, 20**, then 4, 5, 8, 10 softkeys are drawn on screen with the **key number** (1, 2, ..., 9, 0) **in the bottom right corner** of the softkey.



SFNUMB=5



SFNUMB=15

1141 MEMORY (BYTE)

1141 **FEW DIS.** (BYTE)

=0: A PC (FEW unit: Floppy, Ethernet, Winchester) is integrated in the control,

=1: no PC (FEW unit: Floppy, Ethernet, Winchester) is integrated in the control.

1161 TOOL.L.N (WORD)

The number written at that parameter is the "threshold" number of tool-life detection. References to addresses T smaller or greater than that applies to a specific tool number or to a group of tools, respectively.

1181 TOOL.GR.L subgroup (BYTE)

1181 **GROUPNUM** (BYTE)

The value of the parameter may be 1, 2, 3 or 4. That parameter specifies the number of tool groups to be distinguished in the course of tool life detection. The number of groups will also determine their size as seen on the table beside.

GROUPNUM	number/size of groups
1	16 / 16
2	32 / 8
3	64 / 4
4	128 / 2

1182 **TOOLLIFE** (BYTE)

When the parameter is

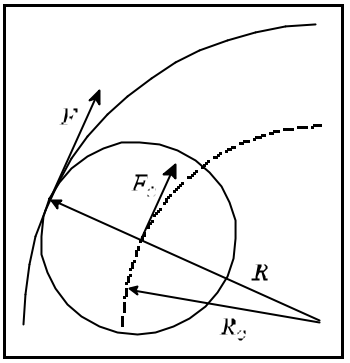
0, the tool life is detected in frequency,

1, the tool life is detected in minutes,

2, the tool life is detected in wear.

1201 OVERRIDE subgroup (BYTE)

1201 **CIRCOVER** (BYTE)



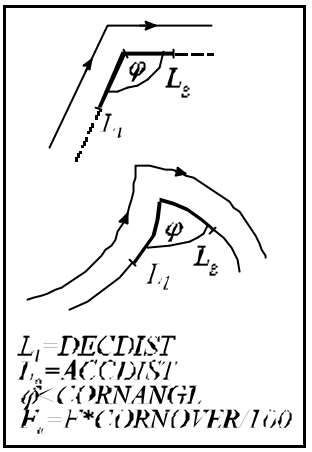
In switched-on state of tool radius offset (G41, G42), in case of inner arc machining the rate of programmed feed (F) is automatically overridden to the tool radius center:

$$F_c = \frac{R_c}{R} F$$

where F_c: tool radius center feed (compensated feed)
R: programmed radius
R_c: compensated radius
F: programmed feed.

Parameter *CIRCOVER* circumscribes a bottom limit for automatic feed reduction, where the reduced feed minimum can be given in percentage value, i.e. condition $F_c \geq F$*CIRCOVER/100 is true for the current feed. The value limit of parameter is 1–100%.

1202 **CORNOVER** (BYTE)



In case of inner corner machining (G62) and in switched-on state of tool radius offset calculation (G41, G42) the corner override function is validated in distance DECDIST before the corner and to distance ACCDIST after the corner on the basis of relationship F*CORNOVER/100 where F is the programmed feed. The value limit of parameter is 1–100%.

1203 **CORNANGL** (BYTE)

In case of inner corner machining and in switched-on state of G62 and tool radius offset calculation (G41, G42) the corner override function is affected if the corner angle is less than the value at parameter CORNANGL. The value limit of parameter is 0–180 deg.

☞ *Note*: See subgroup **DISTANCE**!

1204 **RAPOVER** (BYTE)

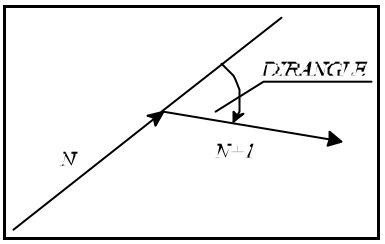
1204 **RAPOVER**=0	
RH089	%
1	1
2	2
3	5
4	10
5	20
6	30
7	40
8	50
9	60
10	70
11	80
12	90
13	100

1204 **RAPOVER**>0	
RH089	%
0	F0=RAPOVER
1	25
2	50
3	100

The NC can take the value of rapid traverse override from two tables. The percentage values of override can be seen in the tables beside. If 1204 **RAPOVER**=0, the first table, if 1204 **RAPOVER**>0 the second one is taken.
Value F0 can be defined on parameter 1204 **RAPOVER**.
Advised value is: $1 \leq RAPOVER \leq 10$.

1205 **DIRANGLE** (BYTE)

If in the part program between two blocks the direction change of velocity vector measured in degrees greater than the value of parameter at the end point of the previous block the feed is decelerated then at the begining of next block accelerated. The value limit of parameter is 0–180 deg. It is used e.g. during DNC machining to avoid shaking of slides and in order to keep them more tightly on programmed path.



***1221 CODES** subgroup (BIT)*

1221 **G00 G01** (BIT)
1222 **G17 G18** (BIT)
1223 **G49 G43** (BIT)
1224 **G49 G44** (BIT)
1225 **G90 G91** (BIT)
1226 **G94 G95** (BIT)

This group of parameters determines the selection of the particular G codes, that are effective after power-on. In the case 0 or 1, it will assume the command of the first or the second column, respectively. When each of parameters **G49**, **G43** and **G49**, **G44** is

assigned 0, it assumes command G49. It assumes command G43 when 1 is assigned to each of them.

☞ *Note*: See also **CLEAR** parameter.

1227 **MULBUF** (BIT)

0: simple pre-reading. In the course of block processing the control loads in advance only the minimum number of blocks needed for the processing.

1: multiple pre-reading. In the course of block processing the control loads in advance the maximum number of blocks possible.

***1241 MIXED** subgroup (BIT)*

1241 **POSCHECK** (BIT)

0: no position check is made after execution of command G00.

1: a position check is made after execution of command G00.

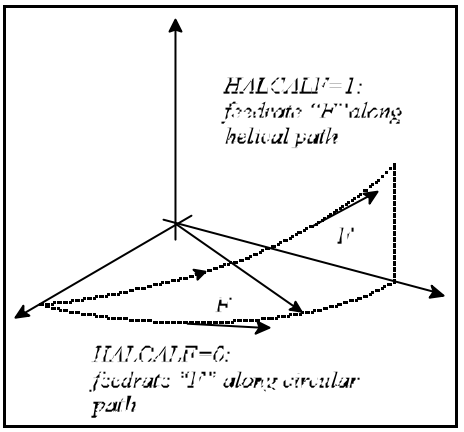
Position check is executed for all axes. An axis is considered to be in "position" if the absolute value of following error is less than the value set at parameter 426n INPOSn. If the in position state does not occur within 5 seconds after the interpolation is over error message POSITION ERROR No. 1020 is sent by the control.

☞ *Note*: See also parameter **INPOS**.

1242 **HELICALF** (BIT)

0: in helical interpolation, the programmed F will be effective in the plane of the circle.

1: in helical interpolation, the programmed F will be effective along the path.



1243 **CLEAR** (BIT)

0: resetting without clearing G functions,

1: resetting with clearing G functions.

The clear applies to modal G functions. G code groups in 1221 CODES parameter group gain values according to the parameter. The clear of G functions comes into effect at the end of program as well as after total reset of automatic mode .

☞ *Note*: See also parameter **CODES**.

1244 **SECOND** (BIT)

0: states G94, G95 are effective in command G04.
In case of G94 the delay is in seconds, while
in case of G95 it is in spindle revolutions.

1: states G94, G95 are ineffective in command G04, for the delay is always in seconds

1245 **TAPDWELL** (BIT)

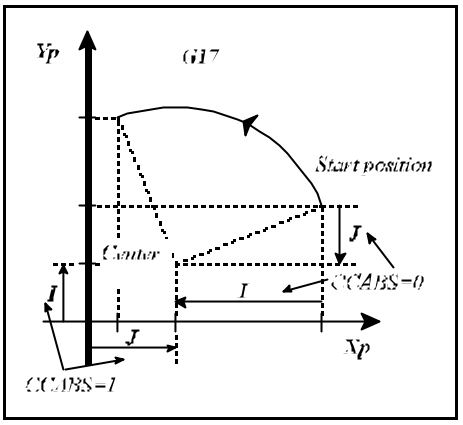
0: no dwell is enabled in tapping cycles G74 and G84.

1: dwell at the bottom of the hole can be programmed at address P in tapping cycles G74 and G84.

1246 **CCABS** (BIT)

0: giving center position with coordinates I, J and K relative from the start position of the circle,

1: giving center position with coordinates I, J and K in absolute system.



1247 **ANG.ACRY** (BIT)

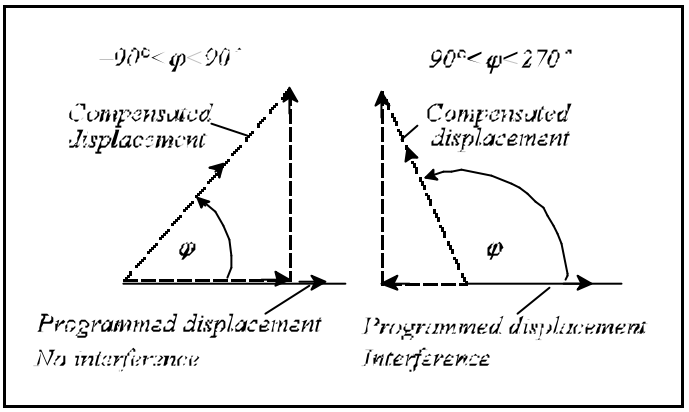
0: calculating angle values with an accuracy of 3 decimal digits,

1: calculating angle values with an accuracy of 5 decimal digits

in case of rotation programmed with G68.

1261 INTERFER subgroup (BIT)

1261 **INTERFER** (BIT)

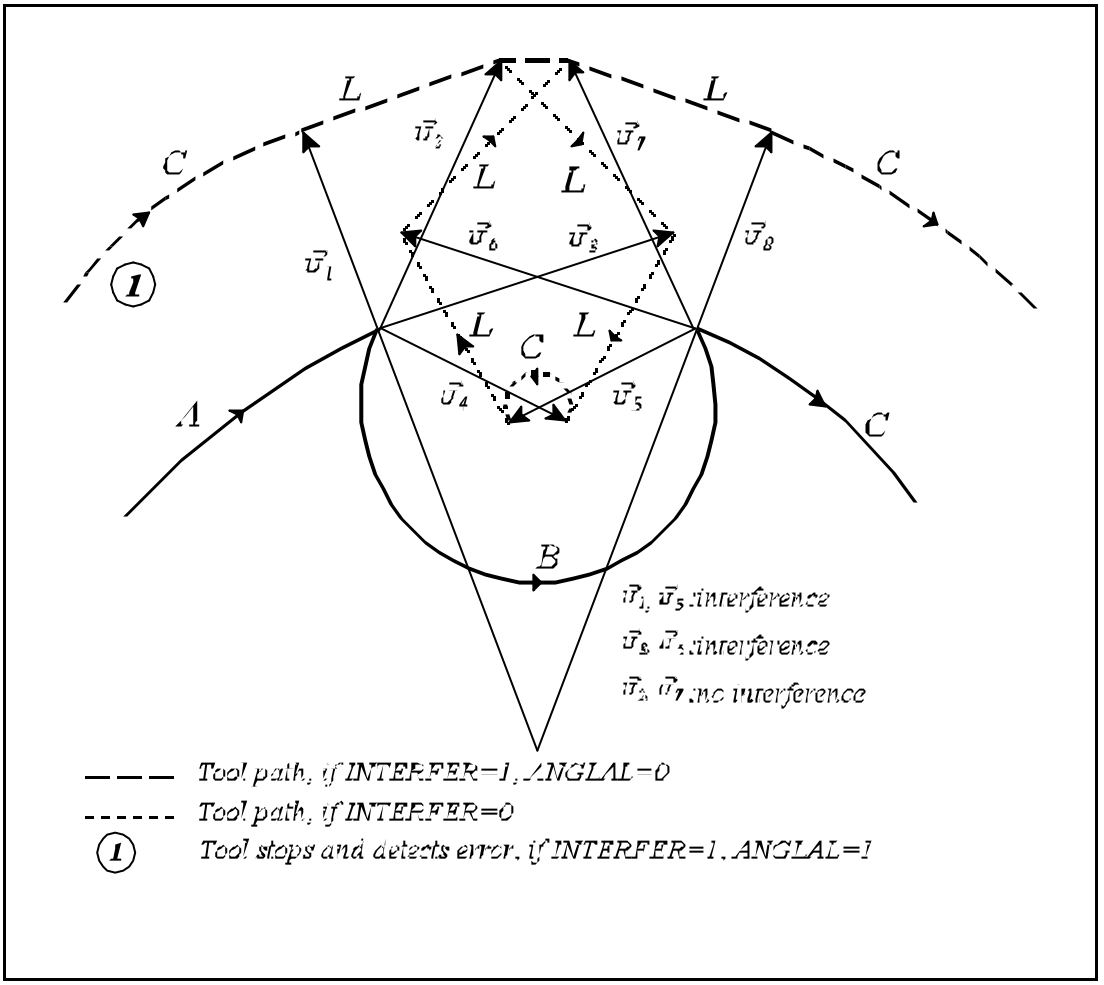


If its value is 0, the control does not perform an interference check in calculating the tool radius offset (state G41, G42); at 1, it performs such a check. Interference error is affected if the angle deviation between the programmed and the compensated displacement is within 90 deg and 270 deg. Iin other words, if the sign of compensated displacement vector component projected on programmed displacement differs in sign from programmed displacement.

1262 **ANGLAL** (BIT)

In calculating tool radius offset (state G41, G42) if both the value of parameter *INTERFER* and of parameter *ANGLAL* is set to 1 the control signals interference error by means of code *3048 INTERFERENCE ALARM* one block before the error had taken place.

In case parameter *ANGLAL* is set to 0 but parameter *INTERFER* is 1, the control does not signal error, but automatically tries to compensate the contour in order to prevent cut-ins. The compensation process is as follows:



The offset mode is switched on regarding blocks A, B, and C. Calculated compensation vectors between blocks A and B: $\vec{v}_1$, $\vec{v}_2$, $\vec{v}_3$, $\vec{v}_4$. Between B and C: $\vec{v}_5$, $\vec{v}_6$, $\vec{v}_7$, $\vec{v}_8$.

If there is interference between $\vec{v}_4$ and $\vec{v}_5$ they are abandoned,

If there is interference between $\vec{v}_3$ and $\vec{v}_6$, they are abandoned,

If there is interference between $\vec{v}_2$ and $\vec{v}_7$ they are abandoned,

If there is interference between $\vec{v}_1$ and $\vec{v}_8$ they cannot be abandoned, error occurs .

As seen above the compensation vectors are formed in pairs as start and end positions of block B and are abandoned in pairs. If the number of compensation vectors on one side is one or is reduced to one, then only the ones of the other side are abandoned. The abandoning is continued until the interference is in effect. The first compensation vector of the start position and the last one of the end position of block B cannot be abandoned. If due to the abandonments the interference ceases no error is sent, if not, error *3048 INTERFERENCE ALARM* is generated. The rest compensation vectors left from the abandonments are always connected with straight lines even if block B is a circle.

*1281 **NIBBLE** subgroup (BYTE)*

1281 **M11-1** (BYTE)
...
1304 **M14-6** (BYTE)
1305 **E%MAX** (BYTE)
1306 **ACC%** (BYTE)
1307 **ADDRINP** (BYTE)
1308 **NIENABLE** (BYTE)
Not used.

***1311 NIACC** subgroup (WORD)*

1311 **ACCMAX** (WORD)
1312 **ACCMIN** (WORD)
Not used.

***1331 DOMCON** subgroup (DWORD)*

1331 **DOMCON** (DWORD)
Dominator constant of 3D tool compensation. The control generates compensation vector components in the following way:

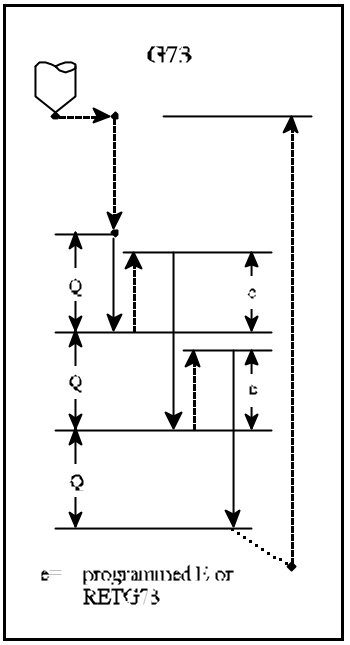
$$v_x = \frac{I*r}{P} ; v_y = \frac{J*r}{P} ; v_z = \frac{K*r}{P}$$

where r: compensation value called at address D,
P: dominator constant,
I, J, K: values given in program..
The dominator constant value is called from parameter *DOMCONST* if no other value is written at address E in block G41(G42) in the program. If the dominator constant value is 0 and no value is given at address E the control calculates value P from the following relationship:

$$P=\sqrt{I^2+J^2+K^2}$$

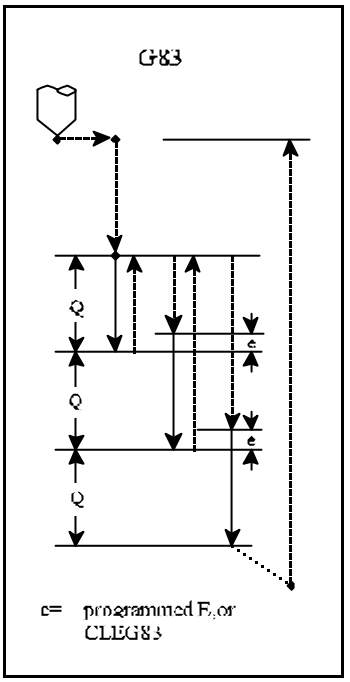
1332 **RETG73** (DWORD)

If no return amount (e) is given at address E in high speed peck drilling cycle G73 the control gets value e from parameter *RETG73*. The parameter is interpreted in output increment. If the return amount value is 1mm, enter 2000 at this parameter, provided INCRSYSTB=1, and INCHDET=0.



1333 **CLEG83** (DWORD)

If no clearance amount (e) is given at address E in peck drilling cycle G83 the control gets value e from the parameter *RETG83*. The parameter is interpreted in output increment. If the clearance amount is 1mm, enter 2000 at this parameter, provided INCRSYSTB=1, and INCHDET=0.



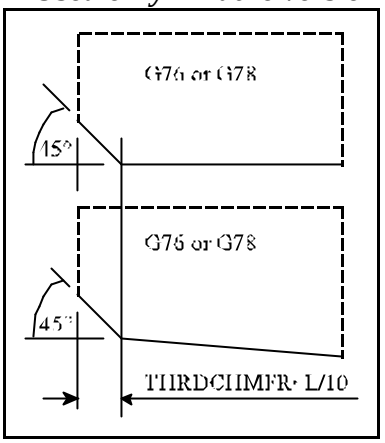
1334 **THRDCHMFR** (DWORD) ***Used only in lathe version***

The chamfering amount at the end of thread in thread cutting cycles G76 and G78. The chamfering angle is always 45 deg. The chamfering amount:

THRDCHMFR·L/10

where: L the programmed tread pitch

If THRDCHMFR=15 and the programmed thread pitch is 1 mm, then the chamfering amount is 1.5 mm. The parameter is also overwritten by program block G76 P(n)(r)(α) Q R (value r of address P_r_).

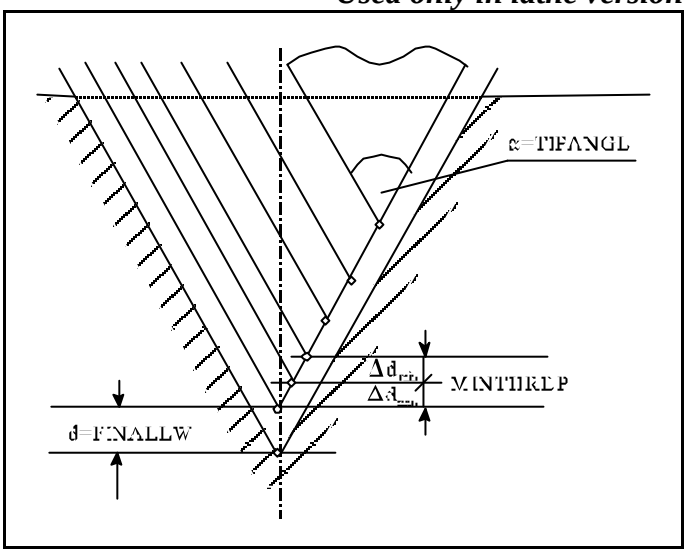


1335 **COUNTFIN** (DWORD) ***Used only in lathe version***

Repetitive count in finishing in thread-cutting cycle G76. The parameter is also overwritten by program block G76 P(n)(r)(α) Q R (value n of address Pn__).

1336 **TIPANGL** (DWORD) ***Used only in lathe version***

Angle of tool tip in degrees in thread-cutting cycle G76. The parameter is also overwritten by program block G76 P(n)(r)(α) Q R (value α of address P__α).



1337 **MINTHRDP** (DWORD)

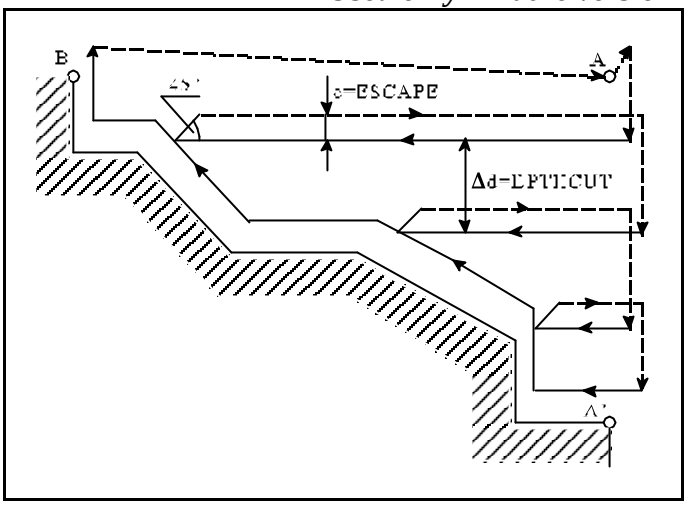
Used only in lathe version

Minimum cutting depth in thread-cutting cycle G76. It is always interpreted in radius and output increment. If the minimum cutting depth value is 0.1mm, enter 200 at this parameter, provided INCRSYSTB=1 and INCHDET=0. The parameter is also overwritten by program block G76 P Q(Δd_{min}) R (value of address Q).

1338 **FINALLW** (DWORD) ***Used only in lathe version***

Finishing allowance in thread-cutting cycle G76. It is always interpreted in radius and output increment. If the finishing allowance value is 0.15mm, enter 300 at this parameter, provided INCRSYSTB=1 and INCHDET=0. The parameter is also overwritten by program block G76 P Q R(d) (value of address R).

1339 **DPTHCUT** (DWORD) ***Used only in lathe version***



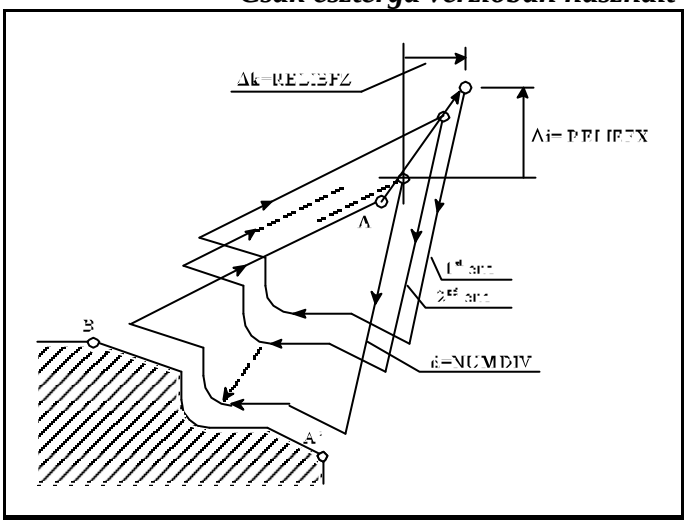
Depth of cut in stock removal cycles G71, G72. It is always interpreted in radius and output increment. If the depth of cut value is 5mm, enter 10000 at this parameter, provided INCRSYSTB=1 and INCHDET=0. The parameter is also overwritten by program block G71 U(Δd) R or G72 W(Δd) R (value of address U or W, respectively).

1340 **ESCAPE** (DWORD)

Used only in lathe version

Escaping amount in stock removal cycles G71, G72. It is always interpreted in radius and output increment. If the escaping amount is 0.5mm, enter 1000 at this parameter, provided INCRSYSTB=1 and INCHDET=0. The parameter is also overwritten by program block G71 U R(e) or G72 W R(e) (value of address R).

1341 **RELIEFX** (DWORD) ***Csak eszterga verzióban használt***



Distance and direction of relief along axis X in pattern repeating cycle G73. It is always interpreted in radius and output increment. If the relief value is 5mm, enter 10000 at this parameter, provided INCRSYSTB=1 and INCHDET=0. The parameter is also overwritten by program block G73 U(Δi) W R (value of address U).

1342 **RELIEFZ** (DWORD)

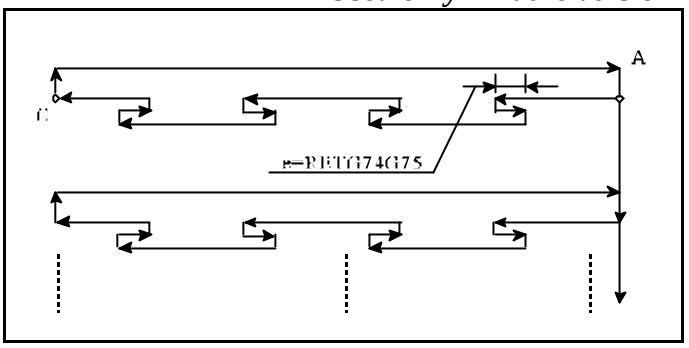
Used only in lathe version

Distance and direction of relief along axis Z in pattern repeating cycle G73. It is always interpreted in radius and output increment. If the relief value is 5mm, enter 10000 at this parameter, provided INCRSYSTB=1 and INCHDET=0. The parameter is also overwritten by program block G73 U W(Δk) R (value of address W).

1343 **NUMDIV** (DWORD) ***Used only in lathe version***

Number of divisions in pattern repeating cycle G73. The value given at relief amount (parameter RELIEFX, RELIEFZ) is divided by this number and the division is executed with this value in the course of rough machining. The parameter is also overwritten by program block G73 U W R(d) (value of address R).

1344 **RETG74G75** (DWORD) ***Used only in lathe version***



Return amount in end face and outer/internal diameter drilling cycles G74 and G75. It is always interpreted in radius and output increment. If the return amount is 1mm, enter 2000 at this parameter, provided INCRSYSTB=1 and INCHDET=0. The parameter is also overwritten by program block G74 R(e) or G75 R(e) (value of address R).

1351 TOOLMEAS subgroup (BIT)

1351 **TOOLRAD** (BIT) ***Used only in milling version***

If the value of parameter is 1, the radius of tool, otherwise the diameter of tool can be given in the tool compensation table. In the table always the radius is stored (it is apparent when transferring to external storage), but in case the parameter is 0 the control executes the necessary conversions when displaying values on screen as well as when entering the data.

1352 **LENGTHSG** (BIT)

0: the sign of length compensation value is set to the command G43 when measuring tool length offset.

1: the sign of length compensation value is set to the command G44 when measuring tool length offset.

1353 **OFFSNL** (BIT) ***Used only in lathe version***

When the parameter value is 1 in case of lathe control the cursor is automatically set to the number of compensation register corresponding to the number of the activated tool on tool length measure screen.

1371 FMULT subgroup (BYTE)

1371 **FMULT** (BYTE)

Its shows, how many times must the programmed feed rate be increased in the course of machining, provided the rapid traverse jog key is pressed.

1372 **JOGFEED** (BYTE)

If its value =0, the slides are moved at a feedrate inherited from address F when applying jog buttons.

If its value =1 The movement rate is independent of the inherited value F in jog mode. In this case the feedrate is taken into account according to the state of feed rate switch on the basis of the table beside.

%	G21 mm/min	G20 in/min	rotary table deg/min
0	0	0	0
1	2	0.08	0.4
2	3.2	0.12	0.64
5	5	0.2	1
10	7.9	0.3	1.58
20	12.6	0.5	2.52
30	20	0.8	4
40	32	1.2	6.4
50	50	2	10
60	79	3	15.8
70	126	5	25.2
80	200	8	40
90	320	12	64
100	500	20	100
110	790	30	158
120	1260	50	252

☞ *Note*: See also **JOGPAR** and **AX.LIMIT** groups.

1373 **HNDLFEED** (BYTE)

If its value =0 pulses coming from the handwheel are buffered and after the handwheel stopped, the movement is **not stopped**. In this case the division on handwheel runs **synchronized** with the position done.

If its value =1 pulses coming from the handwheel are not buffered thus when the handwheel is stopped the movement also **stops immediately**. In this case the division on handwheel does **not** run **in synchron** with the position done..

5.5 SERIAL Parameter Group

***2001 BAUD RATE** subgroup (WORD)*

200n **BAUD RATEn** (WORD), n=1..3

Rate of transmission in the serial interface channels. The control regards only the following values to be correct: 110, 134, 150, 300, 600, 1200, 1800, 2000, 2400, 3600, 4800, 7200, 9600, 19200, 38400 and 56000.

***2021 WORD LNG** subgroup (BYTE)*

202n **WORD LNGn** (BYTE), n=1..3

Length of the **character**, i.e. the number of data bits between the START and the STOP bits. Possible values are 5, 6, 7 and 8.

***2041 STOP BIT** subgroup (BYTE)*

204n **STOP BITn** (BYTE), n=1..3

Number of STOP bits.
0: 1 STOP bit.
1: 1.5 STOP bit.
2: 2 STOP bits.

***2061 PRTY CHECK** subgroup (BIT)*

206n **PRTY CHECKn** (BIT), n=1..3

Enabling the generation and checking of PARITY bit.
0: there are no generation of PARITY bit and parity check.
1: in **transmission**, PARITY bit is generated before the STOP bit(s);
in **receive**, the data bits are checked for parity.

***2081 EVEN PRTY** subgroup (BIT)*

208n **EVEN PRTYn** (BIT), n=1..3

In case of parity management (**PRTY CHECKn**=1), if the value of parameter is
=0 odd parity,
=1 even parity
generation and check is accomplished.

2101 EIA subgroup (BIT)

210n **EIAn** (BIT), n=1..3

In transmission, it will determine whether the output code is ASCII or EIA. Since the EIA characters and the ASCII characters are of odd parity and even parity at 8 bits, respectively, the receiving software may automatically distinguish the two kinds of codings. The software passes its judgement after the first significant character (other than BLANK), and will expect the rest in the same code.
0: ASCII,
1: EIA.

2121 CR SPACE subgroup (BIT)

2121 **CR1** (BIT)

When it is 1, character `r` (Carriage Return) is transmitted beside character `s` (Line Feed) through the first serial interface line at the end of each program line.

2122 **SPACE1** (BIT)

When it is 1, **space** characters are transmitted between the words of blocks through the first serial interface line.

2123 **CR2** (BIT)

When it is 1, character `r` (Carriage Return) is transmitted beside character `s` (Line Feed) through the second serial interface line at the end of each program line.

2124 **SPACE2** (BIT)

When it is 1, **space** characters are transmitted between the words of blocks through the second serial interface line.

2125 **CR3** (BIT)

When it is 1, character `r` (Carriage Return) is transmitted beside character `s` (Line Feed) through the third serial interface line at the end of each program line.

2126 **SPACE3** (BIT)

When it is 1, **space** characters are transmitted between the words of blocks through the third serial interface line.

2141 PROTOCOL subgroup (BIT)

2141 **HARDWARE1** (BIT)
2142 **HARDWARE2** (BIT)
2143 **HARDWARE3** (BIT)

2144 **SOFTWARE1** (BIT)
2145 **SOFTWARE2** (BIT)
2146 **SOFTWARE3** (BIT)

5.6 AX.LIMIT Parameter Group

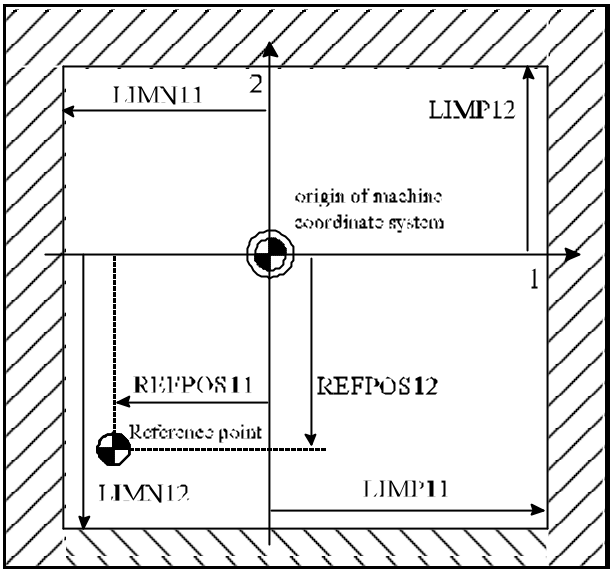
Software stroke limit positions can be specified in both positive and negative directions as well as a forbidden area can be defined in an axis, in which there is a valid reference point.

***3001 LIMP1** subgroup (LONGINT)*

300n **LIMP1n** (INTEGER), n=1..8
Coordinate value of the software limit position on the nth axis in input increments in positive direction in the machine coordinate system.

***3021 LIMN1** subgroup (LONGINT)*

302n **LIMN1n** (INTEGER), n=1..8
Coordinate value of the software limit position on the nth axis in input increments in negative direction in the machine coordinate system.



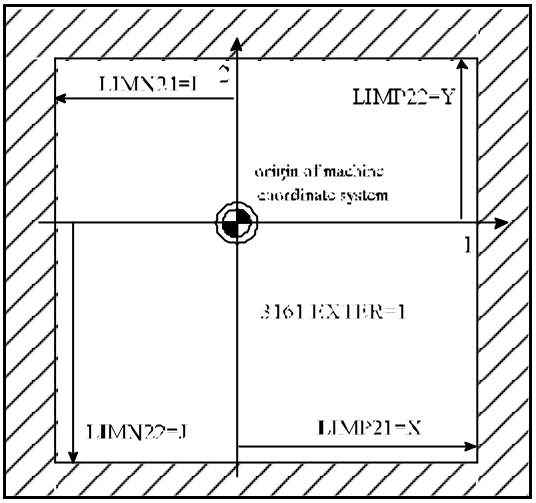
☞ *Note:* If the value of parameter **REFPOS1n** is 0 the origin of machine coordinate system coincides with the reference point. The software limit positions are to be measured every time when the reference point location is changed or parameter **REFPOS1n** is overwritten. See also parameters **LIMBIT1n**

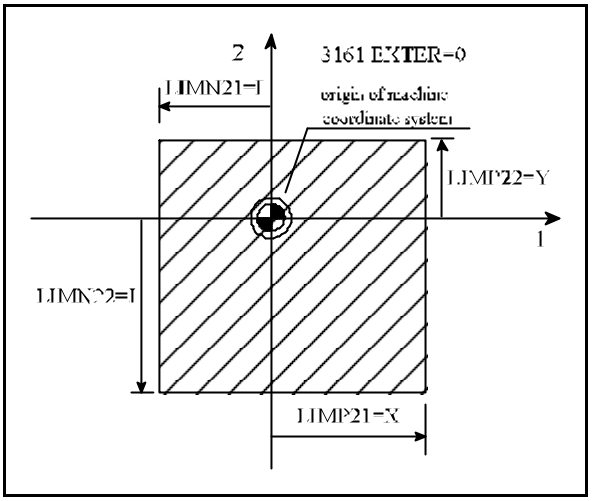
***.3041 LIMP2** subgroup (LONGINT)*

304n **LIMP2n** (INTEGER), n=1..8
Coordinate value of the forbidden area on the nth axis in input increments in positive direction in the machine coordinate system. In command G22 the content of addresses X, Y, Z are written into these registers.

***3061 LIMN2** subgroup (LONGINT)*

306n **LIMN2n** (INTEGER), n=1..8
Coordinate value of the forbidden area on the nth axis in input increments in negative direction in the machine coordinate system. In command G22 the content of addresses I, J, K are written into these registers.





☞ *Note*: The forbidden area specified by parameters **LIMP2n**, **LIMN2n** can be forbidden both internally and externally in function of parameter **EXTER**. If the value of parameter **REFPOS1n** is 0, the origin of machine coordinate system coincides with the reference point. The forbidden area is to be measured every time when the reference point location is changed or parameter **REFPOS1n** is overwritten. Parameter LIMP21 posits value X in command G22, parameter LIMN21 posits value I, ... ect (see diagram), if X is selected for axis No. 1, Y for axis No. 2, ... (parameter AXIS). See also parameters **LIMBIT2n** and **EXTER**.

3121 LIMBIT1 subgroup (BIT)

312n **LIMBIT1n** (BIT), n=1..6

Enabling the detection of software limit position.

0: the software limit position is not detected on the axis concerned.

1: the software limit position is active on the axis concerned.

☞ *Note*: If software limit position detection is enabled at parameters **LIMBIT1n** and the axis enabled for detection runs to limit position, control sends error message LIMIT t+ 134n if the direction is positive and error message LIMIT t– 136n if the direction is negative. Index "t" refers to the axis name (X, Y, ...).

3141 LIMBIT2 subgroup (BIT)

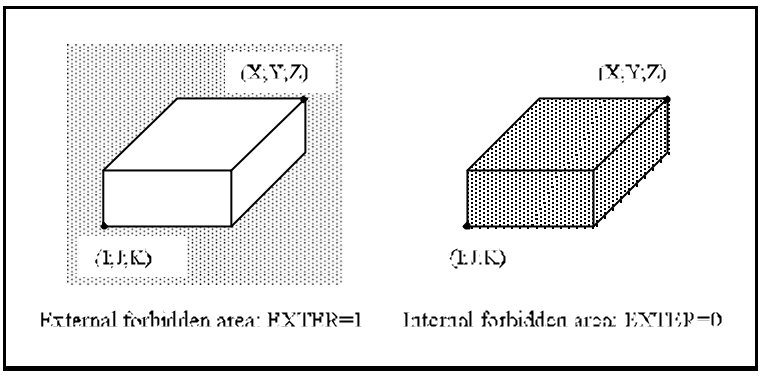
314n **LIMBIT2n** (BIT), n=1..8

Axis addresses in command G22 (X, Y, Z) set the appropriate enabling bit on the given axis.

0: forbidden area detection is disabled on the given axis,

1: forbidden area detection is enabled on the given axis.

3161 STRKCONT subgroup (BIT)



3161 **EXTER** (BIT)

In command G22 X Y Z I J K E value E determines the value of parameter. If E=0 then EXTER=0, if E<0, or E>0 then EXTER=1.

If its value =0: the inside of the space specified by **LIMP2n**, **LIMN2n** is forbidden,

if its value =1: the outside of the space specified by **LIMP2n**, **LIMN2n** is forbidden.

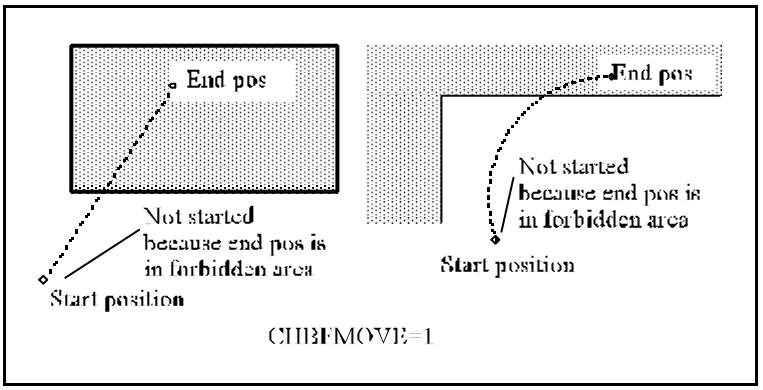
3162 **STRKEN** (BIT)

Command G22 sets the parameter to 1, while command G23 sets it to 0.

If its value =0: forbidden area detection is not enabled,

if its value =1: forbidden area detection is enabled.

☞ *Note*: If forbidden area detection is enabled at parameter **STRKEN** and one axis enabled at parameters **LIMBIT2n** reaches the limit of externally forbidden area (**EXTER**=1) the control sends error message FORBIDDEN AREA t+ No. 130n in case the direction is positive and error message FORBIDDEN AREA t) No. 132n if the direction is negative. Index "t" in the error message refers to the axis name (X, Y, ...). If it reaches the limit of the internally forbidden area (**EXTER**=0) control displays error message INTERNAL FORBIDDEN AREA No. 1400.



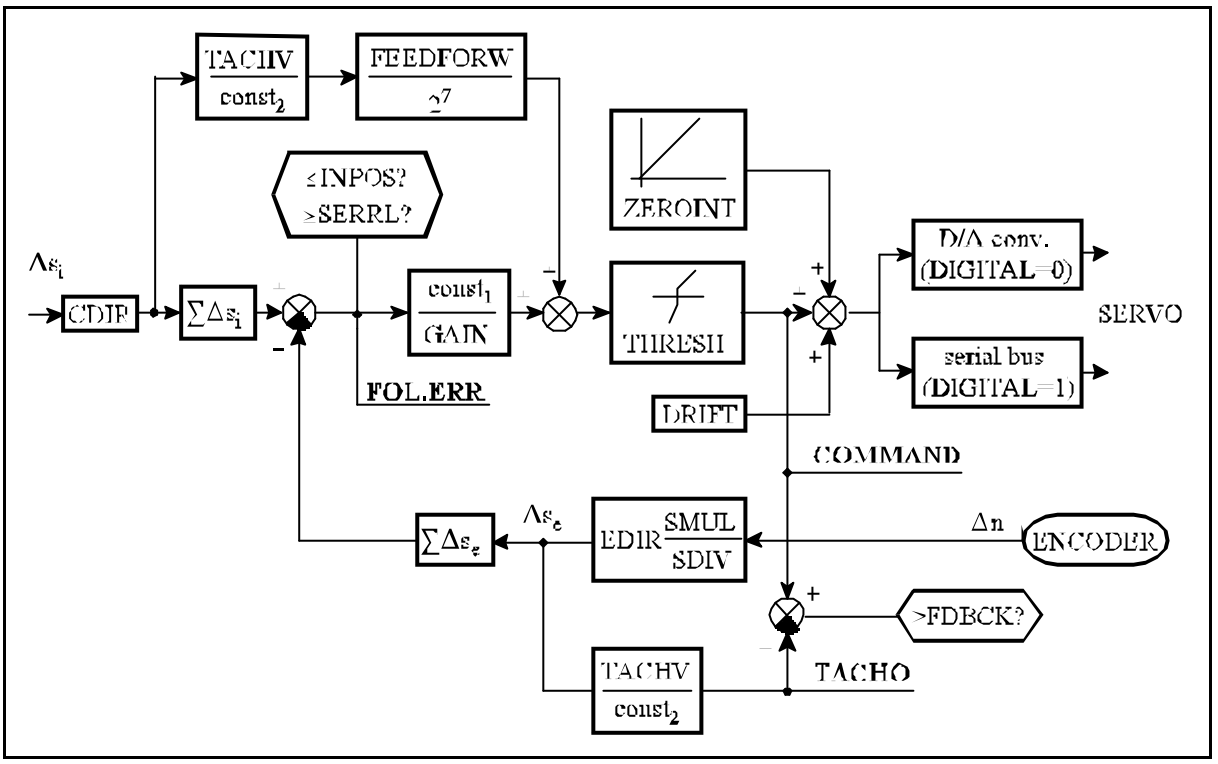
3163 **CHBFMOVE** (BIT)

If its value =0: the control does not execute limit position and stroke limit check for the end position of commanded block before starting the movement,

if its value =1: it executes check and it does not even start the movement, but displays error message LIMIT No. 3056 in case the limit position is out of software limit position as well as error message FORBIDDEN AREA No. 3057 if the limit position is on forbidden area.

5.7 SERVO Parameter Group

Below the block-diagram of the position control loop is shown with the appropriate parameter name indicated by means of which intervention can be made at a position. On the diagram the movement per time unit coming from the interpolator is signed with Δs_i while the one coming from the path measuring encoder with Δs_e. The signals (COMMAND, TACHO, FOLL. ERR), the values of which can be displayed on TEST MES screen are indicated. The signals on which the control executes value limit comparison as well as the names of the parameters by which the value limits can be influenced (INPOS, SERRL, FDBCK) are also indicated. The velocity control loop command signal can be output in analog form after D to A conversion as well as on digital serial bus.



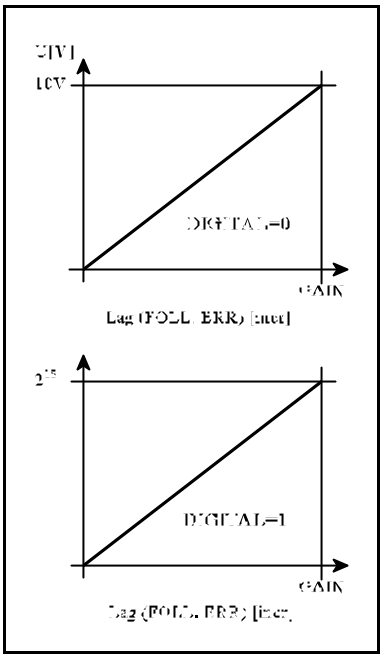
4021 GAIN subgroup (DWORD)

402n **GAINn** (DWORD), n=1..8

Calibration value of analog command signals. It defines lag measured in output increment, at which the analog output voltage is 10V. This value is inversely proportional to the amplification (gain) of the position control loop.
(Calibration values of the position control loop of the spindle can be found in the SPINDLE parameter group.)
Advised value:

GAINn = (1 ... 2)*RAPIDn

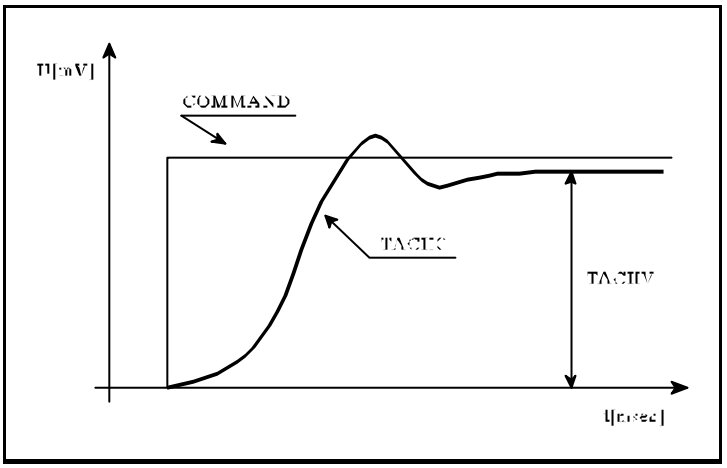
where RAPIDn is the rapid traverse rate of the n^{th} axis.
In case of using digital output it shows the lag at which the control generates 2^{15} command value.



4041 TACHV subgroup (WORD)

404n **TACHVn** (WORD), n=1..8
4049 **TACHVS1** (WORD)
4050 **TACHVS2** (WORD)

Calibration value of the tach signal calculated by the control on 1^{st},.. 8^{th} axis and on 1^{st}, 2^{nd} spindle. Its calibration is needed for the setting of feedback error detection and feedforward. It is not applied for the feedback of velocity control loop (tacho).



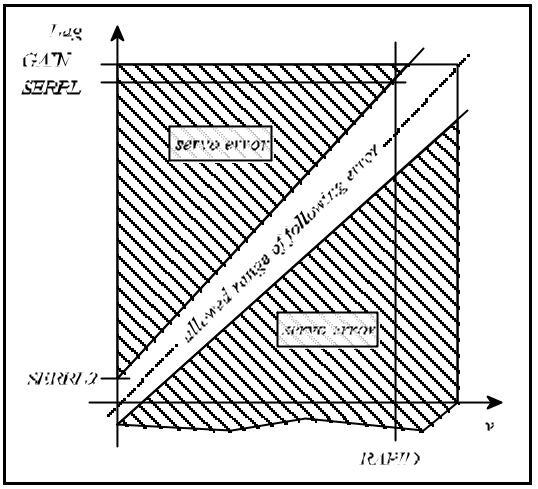
It is set according to TEST MES screen. The axis to be set should be moved at a permanent feedrate. In stationary state the value in COMMAND column of TEST MES screen must be equal to the value in TACHO column. The equality of the two values can be set with the help of parameter TACHV:

$$TACHVn = TACHVn * \frac{COMMANDn}{TACHOn}$$

where: **COMMANDn** is the value in line n and column COMMAND of TEST MES screen,
TACHOn is the value in line n and column TACHO of TEST MES screen.

☞ *Note*: See also parameters **FDBCKn**, **REPFBn**, **TDIRn** and **FDBCKDn**!

*4061 **SERRL** subgroup (DWORD)*



406n **SERRLn** (DWORD), n=1..8
4069 **SERRLS1** (DWORD)
4070 **SERRLS2** (DWORD)

The value of servo error limit on 1st,.. 8th axis and 1st, 2nd spindle. Its unit: output increment. The servo error limit set must be less than the calibration value written at parameter GAIN:

SERRL < GAIN

and greater than the lag belonging to the rapid traverse:

Lag_{RAPID} < SERRL

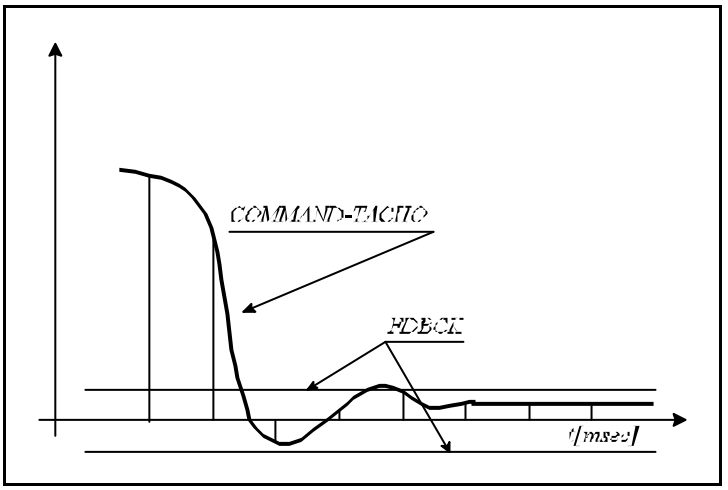
The servo error limit alters in function of the speed. Servo error value belonging to speed 0 (SERRL2) and that belonging to the rapid traverse (SERRL) are connected by the control with a straight with the help of the relation below:

$$servoerror = \frac{SERRL - SERRL2}{RAPID} v + SERRL2$$

where v is the current speed commanded by the interpolator. The servo program checks every 5 (or 2) ms, whether the delay belonging to speed v commanded by the interpolator has reached the value calculated on the basis of the above relation. If yes, it stops the interpolator and sends error message SERVOn after the number of 5 (2) ms cycles defined at parameter REPSLn has elapsed, provided no feedback occurs, i.e. the lag does not fall under the limit. If it does before the cycle has elapsed no error is sent.

☞ *Note*: See also parameters **REPSLn** and **SERRL2**!

***4101 FDBCK** subgroup (WORD)*



410n **FDBCKn** (WORD), n=1..8
4109 **FDBCKS1** (WORD)
4110 **FDBCKS2** (WORD)

The enabled maximum difference between velocity command of drive coming from the control (COMMAND) and the current velocity measured by the encoder (TACHO) on the 1st,.. 8th axis and the 1st, 2nd spindle. The velocity command signal coming from the control can be seen in COMMAND column of TEST MES screen, while the one measured by the encoder is in TACHO column. The servo program evaluates in every

T=5ms, whether the difference between the velocity command and the actual axis rate is durably over the limit given at the parameter, or not.

$$FDBCK < |COMMAND - TACHO|$$

If the difference is greater than the value of this parameter the servo program evaluates, whether this error is permanent, i.e. the inequality is true T***REPFBn** time later, or not.
If it is true;

– the analog output lines are zeroed,
– operating voltage **MACH ON** is switched off,
– error message FEEDBACKn No. 40...48 according to the given axis is displayed.

In order to operate the detection correctly the setting discussed at parameter TACHV is necessary. This error detection makes a faster intervention possible, than that of the servo error detection and it is very effective e.g. in case of breaking the clutch of the encoder.
Advised values: 300...500.

☞ *Note*: See also parameters **REPFBn**, **FDBCKDn**, **TDIRn** and **TACHVn**!

*4121 **DRIFT** subgroup (INTEGER)*

412n **DRIFTn** (INTEGER), n=1..8
4129 **DRIFTS1** (INTEGER)
4130 **DRIFTS2** (INTEGER)

Measure of the offset compensation on the 1st,... 8th axis and the 1st, 2nd spindle .
If offset error occurs in the control loop or in the output command signal the contents of lag register is not 0 in stopped state of axis as it would be preferable or in case of zero command signal the spindle does not stop but creeps. This offset error can be ceased with the help of this parameter. On position controlled axes offset compensation can be done automatically by applying parameter ZEROINT.

***4141 SMUL** subgroup (WORD)*

414n **SMULn** (WORD), n=1..8
4149 **SMULS1** (WORD)
4150 **SMULS2** (WORD)

Multiplying the encoder pulse of the 1st,... 8th axis and the 1st, 2nd spindle. The task of the multiplicator (and divisor **SDIVn**) parameters to fit the pulse number incoming from the encoder so that the distance between the two consecutive encoder pulses on the given axis would be 1 output increment.
Its definition if the rotary encoder is on the motor axis:

$$\frac{lead\ of\ ball\ screw[incr]+modification}{2+ENCODER_n} = \frac{SMUL_n}{SDIV_n}$$

$$modification=\frac{number\ of\ ball\ screw\ revolutions}{1\ encoder\ revolution}$$

Example lead of ball screw: 2mm = 2000[µm]
number of encoder pulses: 2500

cog number of wheel on ball screw: 40
cog number of wheel on motor: 18

$$modification = \frac{18}{40} = 0.45$$

$$\frac{2000*0.45}{2*2500} = 0.18 = \frac{9}{50} = \frac{SMUL_n}{SDIV_n}$$

☞ *Note*: See also parameters **SDIVn**.

***4161 SDIV** subgroup (WORD)*

416n **SDIVn** (WORD), n=1..8
4169 **SDIVS1** (WORD)
4170 **SDIVS2** (WORD)

Dividing the encoder pulses of the1st,..., 8th axis and the 1st, 2nd spindle. **It cannot register 0!!**

☞ *Note*: See also parameters **SMULn**.

***4181 REPSL** subgroup (BYTE)*

418n **REPSLn** (BYTE), n=1..8
4189 **REPSLS1** (BYTE)
4190 **REPSLS2** (BYTE)

Delaying cycle number for the detection of the servo error of the 1st,..., 8th axis and the 1st, 2nd spindle.

The servo program checks every 5 (or 2) ms, whether the lag has reached the servo error limit. If yes, it sends error message SERVO after the number of 5 (2) ms cycles defined at parameter REPSL has elapsed, provided no feedback control occurs, i.e. the lag does not fall under the limit. If it does before the cycle has elapsed no error is sent.

Since there is significant time between the interpolator stop and the stop of axes' movement, the decrease time of the lag has to be measured (magnitude order: 100 msec) and set at the parameter.

Advised value: 40 (100) (*5 or 2 msec).

☞ *Note*: See also parameters **SERRLn**!

***4221 REPFB** subgroup (BYTE)*

422n **REPFBn** (BYTE), n=1..8
4229 **REPFBS1** (BYTE)
4230 **REPFBS2** (BYTE)

Delaying cycle number for the setting of feedback detection.

The drive command signal coming from the control (COMMAND) can be seen in COMMAND column of TEST MES screen, while the velocity measured by the encoder is in TACHO column. The servo program evaluates in every T=5ms, whether the difference

between the command signal and the axis velocity is over the limit specified at the parameter, or not:

FDBCK < |COMMAND – TACHO|

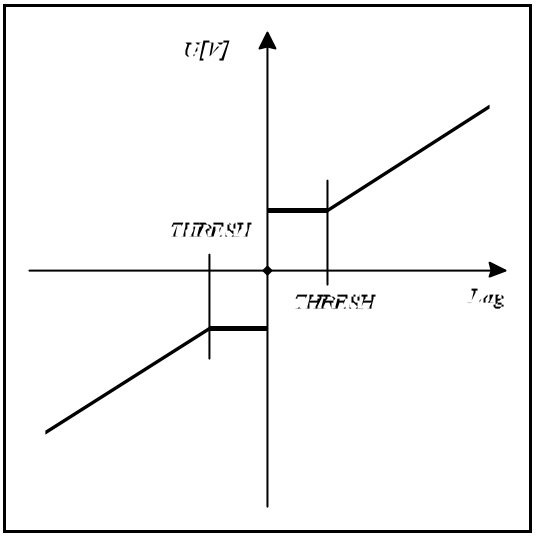
If the difference is greater than the value of this parameter the servo program writes the value of parameter REPFBn into a counter, than it is decremented at every loop close of the given axis. If the error is ceased the process starts from the beginning. In case the error is durable and the register changes to 0 and error *FEEDBACKn* No. 40...48 occurs.
Advised value: 5...25, (15... 75) (*5, or 2 msec)

☞ *Note*: See also parameters **FDBCKn** and **TACHVn**!

***4241 THRESH** subgroup (WORD)*

424n **THRESHn** (WORD), n=1..8
4249 **THRESHS1** (WORD)
4250 **THRESHS2** (WORD)

Threshold value of the non-linear range of analog output signals.
If the lag is 0 the analog output signal is 0V.
If the absolute value of lag is larger than the value of THRESHn the analog output signal is calculated according to linear characteristics.
If the absolute value of lag is less than the value of **THRESHn** the analog output signal agrees with the THRESHn lag value.



***4261 INPOS** subgroup (WORD)*

426n **INPOSn** (WORD), n=1..8
4269 **INPOSS1** (WORD)
4270 **INPOSS2** (WORD)

The tolerance interval of the contents of lag registers in stopped state. After the positionings the system tests, whether the contents of lag register of the given axis is less than the value of **INPOSn** or not. If it is less, then there is no intervention. If it is greater or equal and this state subsists after 2.5 seconds the system sends warning message *POSITION ERROR* No. 1020. Thus signals the machine, that the drift of servos is too big and this injures the accuracy of the machine.
It must be specified in function of the thermostablility of the servo system.

☞ *Note*: See also parameter **POSCHECKn**.

***4281 AXIS** subgroup (BYTE)*

4281 **X** (BYTE)
4282 **Y** (BYTE)
4283 **Z** (BYTE)
4284 **U** (BYTE)
4285 **V** (BYTE)
4286 **W** (BYTE)
4287 **A** (BYTE)
4288 **B** (BYTE)
4289 **C** (BYTE)

At the above parameters the appropriate physical (1, 2, ...) axis number can be assigned for logic (X, Y, ...) axes. If for example on the 1st XMU board axis Z needs to receive the 3rd encoder input and send the command signal through the 3rd analog output line then 3 should be entered at parameter 4283 AXISZ. Naturally in this case parameters referring to axis Z are also posited from index 3 (GAIN3, TACHV3, ect.).
The numbering of parameters is as follows: 1st, ..., 4th I/O of 1st XMU board corresponds to parameter indexes 1, ..., 4; 1st, ..., 4th I/O of 2nd XMU board corresponds to parameter indexes 5, ..., 8. E.g.: index of parameters belonging to axis of encoder input 1 and analog output 1 is also 1.

***4301 CDIR** subgroup (BIT)*

430n **CDIRn** (BIT), n=1..8
4309 **CDIRS1** (BIT)
4310 **CDIRS2** (BIT)

Change of movement direction of axes controlled by the NC (interpolator path). It has to be adjusted to each axis, so that positive slide movements belong to positive programmed movements.
0: no direction change,
1: command direction of interpolator is reversed.

☞*Warning!*

The parameter value may only be changed in power-off state of the machine *(pressed emergency stop button) otherwise the slide overruns!*

***4321 EDIR** subgroup (BIT)*

432n **EDIRn** (BIT), n=1..8
4329 **EDIRS1** (BIT)
4330 **EDIRS2** (BIT)

It gives the direction of the encoder feedback for each axis. If positive feedback is in the position control loop, it can be canceled by the overwriting of this bit (as if change A-$\overline{A}$ or B-$\overline{B}$ was executed on the encoder).

0: direction not reversed,
1: direction reversed.

4401 ENCD subgroup (BIT)

440n **ENCDn** (BIT), n=1..8
4409 **ENCDS1** (BIT)
4410 **ENCDS2** (BIT)

Disabling encoder error detection. The encoder error detection checks at every position loop close, whether signals $A-\overline{A}$, $B-\overline{B}$ and $C-\overline{C}$ of channels A, B and C of the encoder are the inverse of each other, or not. If not system sends error message ENCODERn No. 20, ..., 28.
0: encoder error detection on,
1: encoder error detection off.

4441 AXIST subgroup (BIT)

444n **AXISTn** (BIT), n=1..8
4449 **AXISTS1** (BIT)
4450 **AXISTS2** (BIT)

Enabling the function of the servo program. If the enabling is lacked the given axis is left totally alone, no supervision is done by the control. The number of axes appearing on the enabling list, the number of axes, on which the servo program executes loop close in every T=5ms.
Parameters AXIST1, ..., AXIST4 refer to 1^{st}, ..., 4^{th} I/O of 1^{st} XMU board, parameters AXIST5, ..., AXIST8 refer to 1^{st}, ..., 4^{th} I/O of 2^{nd} XMU board.
On which I/O of which XMU board parameters AXISTS1, AXISTS2 (spindle) refer to is decided by parameters 5025 IOSELS1, 5026 IOSELS2.
The servo program should be enabled for NC axes selected at parameters AXIS as well as for PLC axes selected on flags Y63n from the PLC program..
Parameters AXISTS1, AXISTS2 must be enabled only if encoder is built on the 1^{st}, 2^{nd} spindle. See also parameters ORIENT.
0: disabled,
1: enabled.

4461 NOLOOP subgroup (BIT)

446n **NOLOOPn** (BIT), n=1..8
4469 **NOLOOPS1** (BIT)
4470 **NOLOOPS2** (BIT)

It opens the position control loop in the servo program if it is 1. If encoder or linear scale is mounted on a manual handle axis its position can be displayed by the control without the servo program closing the position control loop.
Parameters NOLOOPS1, NOLOOPS2 must be set to 0 if the position control loop can be closed on spindle, i.e. the spindle can be indexed (see parameters 5282 INDEX1, 5302 INDEX2).
0: position control loop on,
1: position control loop off.

*4481 **ZEROINT** subgroup (WORD)*

448n **ZEROINTn** (WORD), n=1..8
4489 **ZEROINTS1** (WORD)
4490 **ZEROINTS2** (WORD)

Zero integration. This parameter serves for the automatic compensation of the drift in the stopped state of any axis. If in stopped state the lag error is other than 0 (value of FOLL.ER column of TEST MES screen) the control forms a so called integration signal component, which the effect of drift is compensated by, therefore no lag error in opposite direction is needed for the balancing of drift. The integration signal does not change during movement. If the drift does not change in the course of movement the integration signal must not be altered at the next stop, and even if it changes, the signal has to be modified only in accordance with the change. Value of parameter **ZEROINT** defines the integration rate.
In case of 0 there is no integration.
Advised value limit: 20 - 50.

*4501 **FEEDFORW** subgroup (BYTE)*

450n ***FEEDFORW*n** (BYTE), n=1..8
4509 ***FEEDFORW*S1** (BYTE)
4510 ***FEEDFORW*S2** (BYTE)

Feedforward of displacements sent by the interpolator to the measuring system. If its value is 0 there is no feedforward, if its value is 128 the feedforward is the maximum (100%).

*4621 **GANTRY** subgroup (BYTE)*

462n **GANTRYn** (BYTE), n=1..8

Either two axes can be assigned for synchronous operation. In this case the control ensures the coordination of movements of both axes by means of regulation technics. One axis is the master the other one is the slave. The number of parameter to be used is that of the axis number of slave and its value is the axis number of the master. E.g. if axis No. 1 is the master and axis No. 4 is the slave the correct parameter adjustment is:

GANTRY4=1

For the master axis if it is referred to in part program should be assigned a name in AXIS parameter group: e.g. X=1. It is not obligatory to assign a name for the slave axis. The slave axis always follows the master either it is referred to in part program or moved in one of the manual operation modes. The slave after the master has finished the reference point return automatically returns to referencepoint. The position synchronization between them can be adjusted on parameter REFPOSn

*4641 **MULG** subgroup (WORD)*

464n **MULGn** (WORD), n=1..8

Position difference multiplicator. The higher its value, the stronger the synchronization of the two axes with gantry relation. If it is too high the slave axis may oscillate.
The number of parameter to be used is that of the axis number of slave.

4661 DIFG subgroup (WORD)

466n **DIFGn** (WORD), n=1..8

Maximum position difference between master and slave axis. If the position difference exceeds this limit the control sends error message SYNC FAILER n No. 90 ... 97 and switches off the machine.
The number of parameter to be used is that of the axis number of slave.

4681 RAPID subgroup (WORD)

468n **RAPIDn** (WORD), n=1..8
4689 **RAPIDS1** (WORD)
4690 **RAPIDS2** (WORD)

The rapid traverse rate of the given axis, at which the rapid traverse positioning with command G0 is executed in $\frac{mm}{min}$ (INCHDET=0) or in $\frac{inch}{min}$ (INCHDET=1) in case of linear axis, and in $\frac{^\circ}{min}$ in case of rotary axis. The rapid traverse rate of manual handle and reference point return may differ from this rapid traverse rate.
In case of the coordination of more axes the movement is always on linear path at a rate, which does not exceed any of the rapid traverse values specified on the given axes.
If the spindle(s) can be indexed (5282 INDEX1=1 or 5302 INDEX2=1) the rapid traverse rate of spindle positioning (RAPIDS1, RAPIDS2) is interpreted as follows:
If parameter 5284 INDEXC_1 or 5304 INDEXC_2 0, i.e. the positioning is executed to M function:

$$RAPIDS1 = n \cdot 4 \cdot ENCODERS1 \cdot \frac{1}{10}$$

If parameter 5284 INDEXC_1 or 5304 INDEXC_2 is 1, i.e. the positioning is executed to angle value given at address C:

$$RAPIDS1 = \frac{4 \cdot ENCODERS1 \cdot 360}{720000} \cdot n$$

Where n: the revolution of spindle in $\frac{rev}{min}$ in case of rapid traverse positioning and

ENCODERS1: resolution of the spindle encoder

If for example the spindle is mounted with a 1024-resolution-encoder and a rapid traverse revolution of 100 $\frac{rev}{min}$ is to be set in case of 5284 INDEXC_1=1, then

RAPIDS1=(204.8≈)205.

☞ *Note*:

– Selection must be made by taking the machine tool and the servo system into account.

– See also groups **JOGRAP** and **REFRAP**.

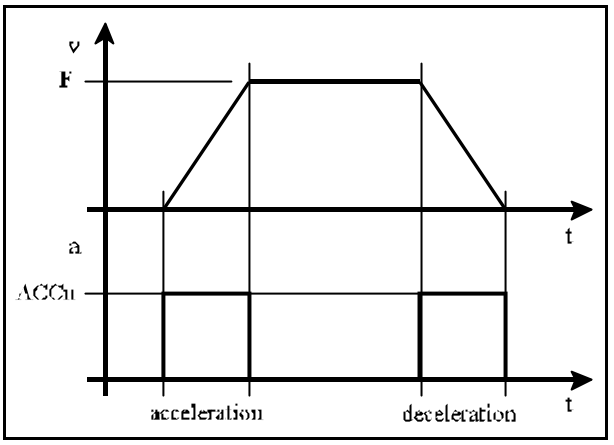
4701 ACC subgroup (WORD)

470n **ACCn** (WORD), n=1..8

Value of acceleration or deceleration on the given axis

in $\frac{mm}{s^2}$ (INCHDET=0) or

in $\frac{inch}{s^2}$ (INCHDET=1) in case of linear axis, and in $\frac{°}{s^2}$ in case of rotary axis. .The control accelerates, as well as decelerates at this value at the beginning and end of every rapid traverse movement.



☞ *Note*: Selection must be made by taking the machine tool and the servo system into account.

4741 FEEDMAX subgroup (WORD)

474n **FEEDMAXn** *(WORD)*
4749 **FEEDMAXS1** *(WORD)*
4750 **FEEDMAXS2** *(WORD)*

The maximum feedrate enabled on the given axis in $\frac{mm}{min}$ (INCHDET=0) or

in $\frac{inch}{min}$ (INCHDET=1) in case of linear axis, and in $\frac{°}{min}$ in case of rotary axis. If G1 is programmed the programmed resultant feed value (F) is , if necessary, modified by the control, so that the rate component of the given axis would not exceed the value specified on that axis. In case of DRY RUN the feed movements are executed at this rate independent of the programmed feed rate.

Its value must be less than the rapid traverse value, because automatic acceleration or deceleration is not applied for feed movements by the control in all cases (G33).

If the spindle(s) can be indexed (5282 INDEX1=1 or 5302 INDEX2=1) and is indexed at address C (parameter 5284 INDEXC_1 or 5304 INDEXC_2 is 1) the maximum feed rate of spindle(s) (FEEDMAXS1, FEEDMAXS2) is interpreted as follows:

$$FEEDMAXS1 = \frac{4 \cdot ENCODERS1 \cdot 360}{720000} \cdot n$$

where n: the revolution of spindle in $\frac{rev}{min}$ in case of maximum feed rate and

ENCODERS1: resolution of the spindle encoder

If for example the spindle is mounted with a 1024-resolution-encoder and a revolution of 50 $\frac{rev}{min}$ is to be set, then FEEDMAXS1=(102.4≈)102.

***4761 COMMB** subgroup (BIT)*

4761 **INCH INP** (BIT)
0: the default data input is metric,
1: the default data input is in inch.

4762 **DIAM** (BIT)
0: interpretation and display of coordinate data X in radius,
1: interpretation and display of coordinate data X in diameter.

4763 **INCH DET** (BIT)
0: the path detection on linear axes is metric, i.e. output data is metric,
1: the path detection on linear axes is English, i.e. output data is in inch.

4764 **INCRSYSTA** (BIT)
1: 1 input increment on linear axes in metric case: 0.01mm, in inch: 0.001", while on rotary axes: 0.01 deg. The units of output increment are half the appropriate input units in all cases.

4765 **INCRSYSTB** (BIT)
1: 1 input increment on linear axes in metric case: 0.001mm, in inch: 0.0001", while on rotary axes: 0.001 deg. The units of output increment are half the appropriate input units in all cases.

4766 **INCRSYSTC** (BIT)
1: 1 input increment on linear axes in metric case: 0.0001mm, in inch: 0.00001", while on rotary axes: 0.0001 deg. The units of output increment are half the appropriate input units in all cases.

***4781 JOGRAP** subgroup (WORD)*

478n **JOGRAPn** (WORD), n=1..8
The rapid traverse rate valid on each axis in case of JOG rapid movement. Naturally it is less than or equal to the value written at parameter RAPID of the appropriate axis. Its measure unit is interpreted as discussed at parameters RAPID.

4801 **JOGFMAX** subgroup (WORD)

480n **JOGFMAXn** (WORD), n=1..8

The maximum feedrate valid on each axis in case of JOG movement. Naturally it is less than or equal to the value written at parameter FEEDMAX of the appropriate axis. Its measure unit is interpreted as discussed at parameters FEEDMAX.

***4821 HANDWH_D** subgroup (BIT)*

482n **HANDWH_Dn** (BIT), n=1...8

At this parameter the direction of manual handle movements can be set. If the movement direction is not adequate on the n^{th} axis the value of parameter HANDWHDn of the given axis must be set from 0 to 1, or inversely.

***4841 REPDG** subgroup (BYTE)*

484n **REPDGn** (BYTE), n=1..8

The value entered at the parameter shows the number of measuring system cycles the maximum position difference between gantry axes can bear (value of parameter DIFGn). If the difference is durable the control displays error message SYNC FAILER n No. 90 ... 97. The number of parameter to be used is that of the axis number of slave.

***4861 DIGITAL** subgroup (BIT)*

486n **DIGITALn** (BIT), n=1...8
4869 **DIGITALS1** (BIT)
4870 **DIGITALS2** (BIT)

At this parameter one can set for each axis and for spindles separately whether the command signal of velocity control loop may be sent in analog form (DIGITALn=0) or in digital form through serial bus (DIGITALn=1).

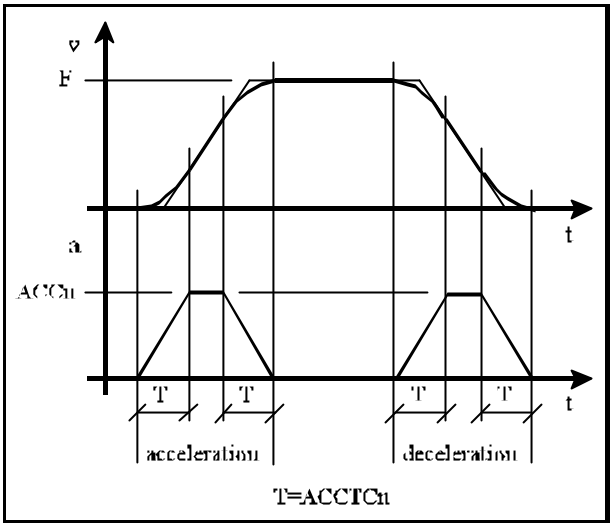
***4881 SERRL2** subgroup (DWORD)*

488n **SERRL2n** (DWORD), n=1..8
4889 **SERRL2S1** (DWORD)
4880 **SERRL2S2** (DWORD)

Value of servo error limit at 0 axis speed. For interpretation see description in parameter group **4061 SERRL**. It is useful when setting its value to consider the lag occurring during switch-on resulting from the analog signal offset error. Its value should be greater than the value set at parameter INPOSn.

4901 ACCTC subgroup (WORD)

490n **ACCTCn** (WORD), n=1..8
Acceleration time constant in msec in case of quadratic acceleration. It shows the msec period, the acceleration value set at parameter 470n ACCn has reached.

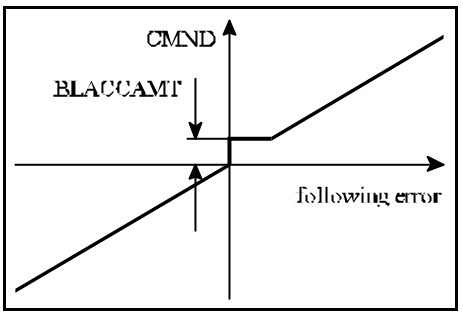


4911 COMPEN subgroup (BIT)

4911 **BLACCEN** (BIT) (BackLash ACCelaration Enable)
=1: backlash acceleration is enabled.
It must be used only when linear scale is applied!
4912 **BLACCSP** (BIT) (BackLash ACCelaration StoP)
=1: ending of backlash acceleration process on basis of path done is enabled.
4913 **SFRCMPEN** (Static FRiction CoMPensation Enable)
=1: compensation of static friction is enabled.
4914 **SFRCMPSP** (Static FRiction CoMPensation StoP)
=1: ending of static friction compensation on basis of path done is enabled.

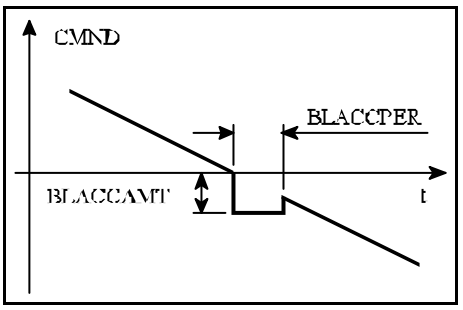
4921 BLACCAMT subgroup (WORD) (BackLash ACCelaration AMounT)

492n **BLACCAMTn** (WORD), n=1..8
Amount of backlash acceleration, i.e. the speed command signal on axis No. 1..8 when the function is activated, independent of the following error.

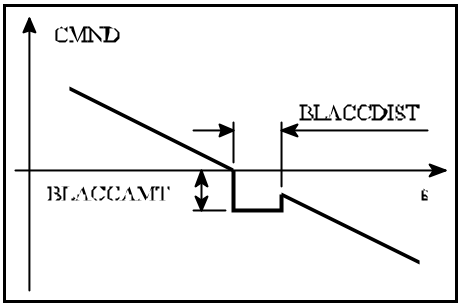


4931 BLACCPER subgroup (WORD) (BackLash ACCelaration PERiod)

493n **BLACCPERn** (WORD), n=1..8
Duration in msec unit of the backlash acceleration being in effect on axis No. 1..8.



***4941 BLACCDIST** subgroup (WORD)* (BackLash ACCelaration DISTance)



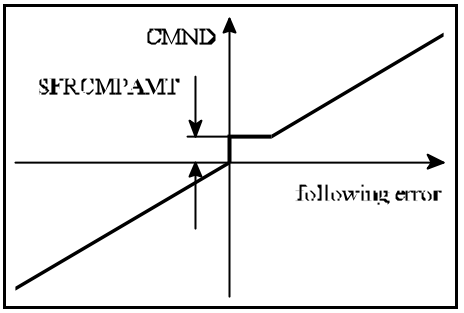
494n **BLACCDISTn** (WORD), n=1..8

If ending of backlash acceleration on basis of the path done is enabled (BLACCSP=1), the path to be done can be defined at this parameter on axis No. 1..8 in input increment.

☞ *Warning!*

Backlash acceleration is ended when the time specified at parameter BLACCPERn has elapsed or the path set at parameter BLACCDISTn is done by axis No. n, or the speed command signal resulting from the following error is greater than the value of parameter BLACCAMTn.

***4951 SFRCMPAMT** subgroup (WORD)* (Static FRiction CoMPensation AMounT)



495n **SFRCMPAMTn** (WORD), n=1..8

Amount of speed command signal on axis No. 1..8 when activating static friction compensation, independent of the lag (following error).

***4961 SPSTPER** subgroup (WORD)* (StoP STate judgement PERiod)

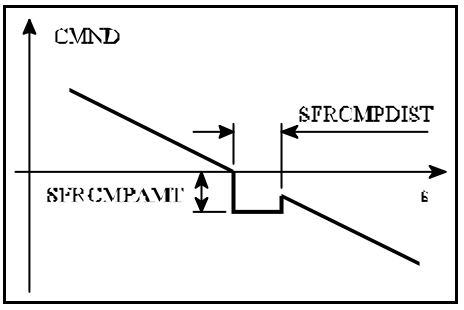
496n **SPSTPERn** (WORD), n=1..8

In order to start static friction compensation the stop state of the given axis must be checked. If the time period set at the parameter in msec unit elapses without movement on axis No. 1..8, the static friction compensation is activated when starting the axis.

☞ *Warning!*

If the value of the parameter is too little the compensation may be activated in case of low feed resulting in non-desired effects.

***4971 SFRCMPDIST** subgroup (WORD)* (Static FRiction CoMPensation DISTance)



497n **SFRCMPDISTn** (WORD), n=1..8

If ending of static friction compensation on basis of the path done is enabled (SFRCMPSP=1) the path to be done can be defined at this parameter on axis No. 1..8 in input increments.

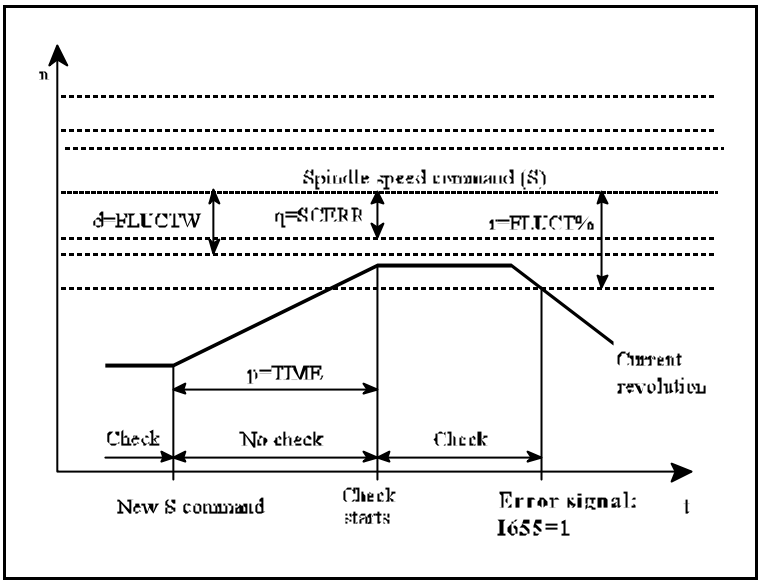
☞ *Warning!*

Static friction compensation *is ended when the path set at parameter SFRCMPDISTn is done by axis No. n, or the speed command signal resulting from the folloing error is greater than the value of parameter SFRCMPAMTn.*

5.8 SPINDLE Parameter Group

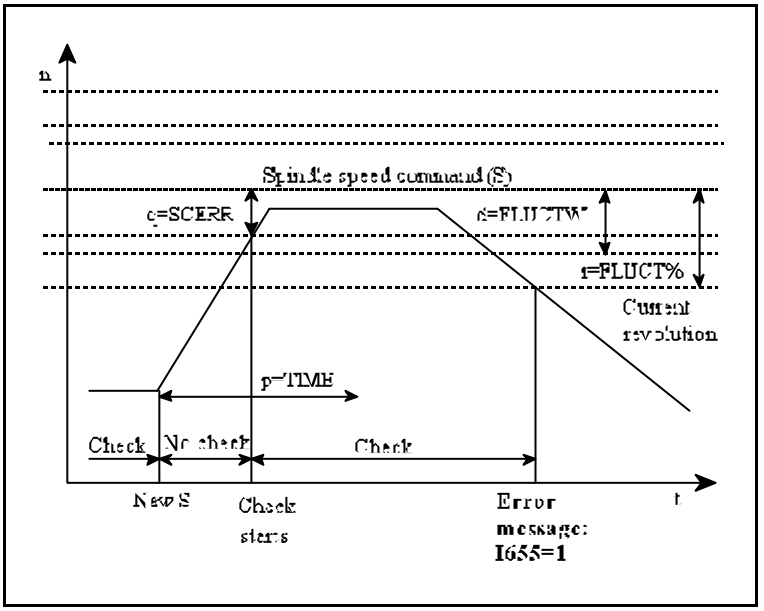
***5001 FLUCT** subgroup (WORD)*

5001 **TIME** (WORD)



Parameter for time between changes in commanded speed and check start. It is effective in state G26. Measure unit: 100 msec.
The parameter is overwritten from part program as the effect of command **G26** Pp Q R D (value of address P).
The fluctuation check starts if the revolution difference between the speed commanded and the current speed is larger than the fluctuation rate defined at parameter **SCERR** and the interval defined on parameter **TIME** has elapsed.

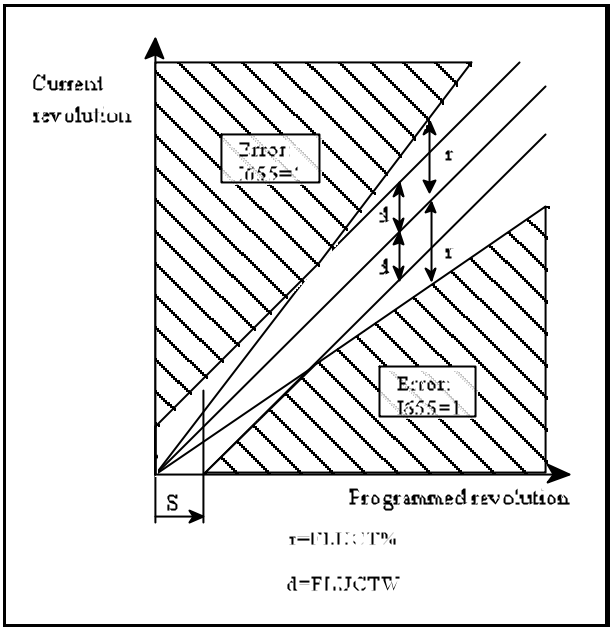
5002 **SCERR** (WORD)



Allowable rate for starting spindle speed fluctuation check in percent. It is effective in state G26. Measure unit: %.
The parameter is overwritten from part program as the effect of command **G26** P Qq R D (value of address Q).
The fluctuation check starts if the rate of difference between the command speed and the current speed is less than the rate defined at parameter **SCERR before** value **TIME** has elapsed.

5003 **FLUCT%** (WORD)

Fluctuation rate in which an alarm is given. It is effective in state G26. Measure unit: %.
The parameter is overwritten from part program as the effect of command **G26** P Q Rr D (value of address R).
The permissible speed fluctuation is in percent of the speed commanded.
If the current spindle revolution is out of both revolution ranges specified by parameters FLUCT% and FLUCTW after the start of fluctuation check, the control sets flag I655 to 1.



5004 **FLUCTW** (WORD)

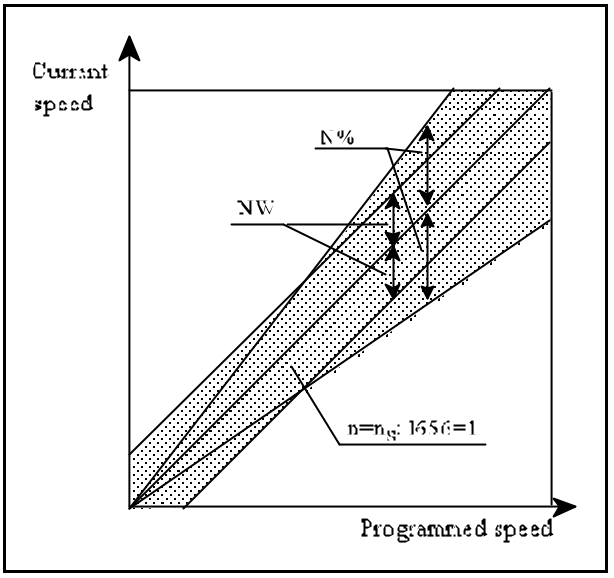
Parameter determining the absolute amount of spindle speed fluctuation with in which an alarm is given. It is effective in state G26.
Measure unit: rev/min.
The parameter is overwritten from part program as the effect of command **G26** P Q R Dd (value of address D).
The permissible spindle speed fluctuation in absolute value.
If the current spindle speed is out of both ranges specified by parameters FLUCT% and FLUCTW after the start of fluctuation check, the control sets flag I655 to 1.

☞ *Notes:*

Parameters above mentioned are referring to the spindle No. 1 and are effective only if spindle No. 1 is active. (In case of PLC flag Y660=0.)

The spindle speed ranges to which the NC sets flag I655 can be seen on the diagram. If the programmed spindle speed is under value "S" seen on diagram the NC sends error signal provided the current revolution is 0 rev/min for more than 1 second.
The check of spindle speed fluctuation is only effective when encoder is mounted on spindle (parameter state ENCODERS1>0).
The speed commanded is compared to the current revolution by taking the override, speed limits belonging the spindle gear ranges and programmed maximum spindle speed (G92 S_) in the state of constant surface speed (G96) into account.
The check of revolution fluctuation is only effective in case of G26 and of rotating spindle (state M3 or M4). After power-on the NC is in state G26 (I654=0). By programming G25 the fluctuation check is canceled.
See also **Programmer's Manual** chapter **Check of Spindle Speed Fluctuation (G25, G26)**.

5005 **N%** (WORD)



Rate in which the spindle speed reached signal $n=n_S$ (I656) is turned on.
Measure unit: %.
If the difference between the programmed (S) and the current spindle revolution is in the interval specified by parameters N% or NW the control sets flag I656 $n=n_S$ to 1.

5006 **NW** (WORD)

Spindle speed width in which the spindle speed reached signal n=nS (I656) is turned on.
Measure unit: rev/min.
If the difference between the programmed (S) and the current spindle revolution is in the interval specified by parameters N% or NW the control sets flag I656 $n=n_S$ to 1.

5007 **N0** (WORD)

Spindle speed width in which the spindle speed reached n=0 (spindle stop) signal is turned on.
Measure unit: rev/min.
If the value of current spindle speed is in the interval specified by parameter N0 the control sends signal n=0, i.e. sets flag I657 to 1.

☞ *Notes:*

Functions $n=n_S$ and n=0 are only effective if encoder is built on the spindle (parameter state ENCODERS1>0).
The speed commanded is compared to the current revolution by taking the override, speed limits belonging the spindle gear ranges and programmed maximum spindle speed (G92 S_) in the state of constant surface speed (G96) into account.
When the spindle is stopped both signals $n=n_S$ and n=0 (I656 and I657) are set to 1.

***5021 ADJUST** subgroup (WORD)*

5021 **ADJUSTS1** (WORD)

5022 **ADJUSTS2** (WORD)

Calibration value of the command signal of 1st, 2nd spindle.
Its setting: Enter 0 at the parameter, command spindle speed of the given range belonging to the 10V command signal, than measure the value of spindle command signal and enter the measured voltage value in mV at this parameter. This parameter must be greater or equal 10000.

5023 **ENCODERS1** (WORD)
5024 **ENCODERS2** (WORD)

Encoder resolution on 1st and 2nd spindle. There has to be 1-1 gear-ratio between encoder and spindle.
The accurate value set is essential because the current revolution is displayed, in case of drilling and thread cutting the thread pitch is calculated and PLC flags I655, I665, I656, I666, I657, I667 are set by the control on the basis of this parameter..
If no encoder is mounted on the spindle 0 must be entered at the parameter. In this case the current revolution is the command revolution on dispay as well as PLC flags I655, I665, I656, I666, I657, I667 are not set.

☞ *Note*: When selecting encoder resolution must be taken into account that the top limit frequency of the receiver circuit in the NC is 500kHz..

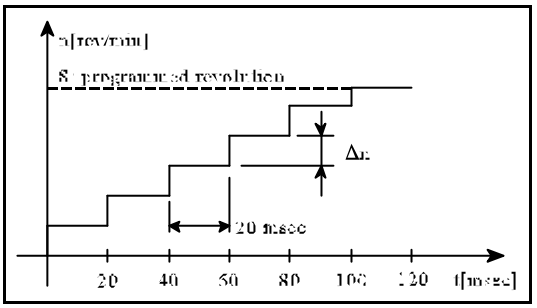
5025 **IOSELS1** (WORD)
5026 **IOSELS2** (WORD)

The physical I/O (encoder input, analog output) to which the 1st and 2nd spindle is connected can be selected at this parameter by writing the axis number.
Value limit: 1) 12.
If for example the spindle is connected to the 4th I/O of the 1st XMU board the number to be entered is 4. If however the spindle is connected to the 4th I/O of the 2nd XMU board the number to be entered is 8.

5041 S1 ACCT subgroup (WORD)

504n **S1 ACCTn** (WORD), n=1..8

Parameter of ramping-up of command signal in the **n**th revolution range of the first spindle.
If the value of parameter is 0, the voltage according to the value written in register RH060 is sent instantly to the output.
If the value of parameter >0, the ramping rate of signal is Δn[rev/min]/20msec, where Δn is calculated from the following relationship:



$$\Delta n = \frac{S1\_10Vn}{const} \bullet S1\_ACCTn$$

Value of constant is 2^{13} in case of analog signal and 2^{15} in case of digital signal.

5061 S1 DECT subgroup (WORD)

506n **S1 DECTn** (WORD), n=1..8

Ramping-down rate of command signal in the **n**th revolution range of the first spindle.
If the value of parameter is 0, the voltage according to the value written in register RH060 is sent instantly to the output..

If the value of parameter >0, the rate of signal ramping is Δn[rev/min]/20msec, where Δn is calculated from the following relationship:

$$\Delta n = \frac{S1\_10Vn}{const} \bullet S1\_DECTn$$

Value of constant is 2^{13} in case of analog signal and 2^{15} in case of digital one.

***5081 S2 ACCT** subgroup (WORD)*

508n **S2 ACCTn** (WORD), n=1..8

Parameter of ramping-up of command signal in the **n**th revolution range of the second spindle.
If the value of parameter is 0, the voltage according to the value written in register RH065 is sent instantly to the output..
If the value of parameter >0, the rate of signal ramping is Δn[rev/min]/20msec, where Δn is calculated from the following relationship:

$$\Delta n = \frac{S2\_10Vn}{const} \bullet S2\_ACCTn$$

Value of constant is 2^{13} in case of analog signal and 2^{15} in case of digital one.

***5101 S2 DECT** subgroup (WORD)*

510n **S2 DECTn** (WORD), n=1..8

Parameter of ramping-down of command signal in the **n**th revolution range of the second spindle.
If the value of parameter is 0, the voltage according to the value written in register RH065 is sent instantly to the output..
If the value of parameter >0, the ramping rate of signal is Δn[rev/min]/20msec, where Δn is calculated from the following relationship:

$$\Delta n = \frac{S2\_10Vn}{const} \bullet S2\_DECTn$$

Value of constant is 2^{13} in case of analog transfer and 2^{15} in case of digital transfer.

***5121 S1 10V** subgroup (WORD)*

512n **S1 10Vn** (WORD), n=1..8

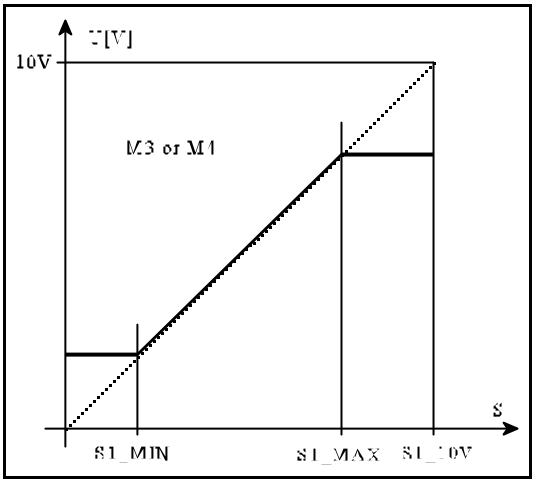
They specify the spindle speed in eight gear ranges of the 1st spindle belonging to 10V analog output. The particular revolution has to be specified in $\frac{rev}{min}$ in each range, at which the spindle would be rotating when the maximum 10 V were available at the analog output.

***5141 S1 MIN** subgroup (WORD)*

514n **S1 MINn** (WORD), n=1..8

Minimum spindle speeds available in eight gear ranges of the first spindle.
The minimum revolution valid in each range has to be specified in $\frac{rev}{min}$.

If the speed commanded in the given range is less than the minimum revolution, this revolution is effective.



***5161 S1 MAX** subgroup (WORD)*

516n **S1 MAXn** (WORD), n=1..8

Maximum spindle speeds available in eight gear ranges of the first spindle. The maximum revolution valid in the range has to be specified in $\frac{rev}{min}$ in each range. It cannot be greater than **S1 10Vn**. If the speed commanded in the given range is greater than the maximum revolution, this revolution is effective.

***5181 S2 10V** subgroup (WORD)*

518n **S2 10Vn** (WORD), n=1..8

They specify the spindle speed in eight gear ranges of the 2nd spindle belonging to 10V analog output. The particular revolution has to be specified in $\frac{rev}{min}$ in each range, at which the spindle would be rotating when the maximum 10 V were available at the analog output.

***5201 S2 MIN** subgroup (WORD)*

520n **S2 MINn** (WORD), n=1..8
Minimum spindle speeds available in eight gear ranges of the second spindle. The minimum revolution valid in each range has to be specified in $\frac{rev}{min}$. If the speed commanded in the given range is less than the minimum revolution, this revolution is effective.

***5221 S2 MAX** subgroup (WORD)*

522n **S2 MAXn** (WORD), n=1..8
Maximum spindle speeds available in eight gear ranges of the second spindle. The maximum revolution valid in each range has to be specified in $\frac{rev}{min}$. It cannot be greater than **S2 10Vn**. If the speed commandded in the given range is greater than the maximum revolution, this revolution is effective.

***5241 SINDEX1** subgroup (WORD)*

5241 **M_NUMB1** (WORD)
It specifies the threshold number, from which the incremental movement can be specified for the first spindle in case of spindle indexing by M function. E.g. at M_NUMB1=100, M160 has to be specified in order to program an incremental movement of 60 deg.

5242 **DIVS1** (WORD)
Its obligatory value is 0.

***5261 SINDEX2** subgroup (WORD)*

5261 **M_NUMB2** (WORD)
It specifies the threshold number, from which the incremental movement can be specified for the second spindle in case of spindle indexing by M function.

5262 **DIVS2** (WORD)
Its obligatory value is 0.

***5281 SORIENT1** subgroup (BIT)*

5281 **ORIENT1** (BIT)
0: the first spindle cannot be oriented.
1: the first spindle is oriented with command M19.
The orientation can be done mechanically as well as by closing the position control loop. In both cases the parameter must be set to 1 for this parameter enables the drilling cycles (G76, G87) needing orientation.

5282 **INDEX1** (BIT)

0: the first spindle cannot be indexed.

1: the first spindle can be indexed, i.e. the position control loop can be closed. At the time of loop closure, the actual position is also displayed beneath the last axis at address **S** or **C**, depending on parameter **INDEX_C1**.

5283 **GRID1** (BIT)

0: the first spindle is oriented in accordance with the reference point return (it runs to switch than searches for zero pulse).

1: the spindle is oriented in accordance with grid zero (it runs only to zero pulse).

5284 **INDEX_C1** (BIT)

0: the first spindle is indexed by function M, position display under address **S**.

1: the first spindle is indexed by address **C**, position display under address **C**.

***5301 SORIENT2** subgroup (BIT)*

5301 **ORIENT2** (BIT)

0: the second spindle cannot be oriented.

1: the second spindle is oriented with command M19.

The orientation can be done mechanically and also by closing the position control loop. In both cases the parameter must be set to 1 for this parameter enables the drilling cycles (G76, G87) needing orientation.

5302 **INDEX2** (BIT)

0: the second spindle cannot be indexed.

1: the second spindle can be indexed, i.e. the position control loop can be closed. At the time of loop closure, the actual position is also displayed beneath the last axis at address **S** or **C**, depending on parameter **INDEX_C2**.

5303 **GRID2** (BIT)

0: the second spindle is oriented in accordance with the reference point return (it runs to switch than searches for zero pulse).

1: the second spindle is oriented in accordance with grid zero (it runs only to zero pulse).

5304 **INDEX_C2** (BIT)

0: the second spindle is indexed by function M.

1: the second spindle is indexed by address **C.**

***5321 GAIN1** subgroup (DWORD)*

532n **GAIN1n** (DWORD), n=1..8

It specifies the values of position control loop gain of the eight gear ranges, when the first spindle position control loop is closed. The spindle encoder must be mounted on the axis of the spindle. See parameter 4021 GAIN of SERVO parameter group for interpretation.

***5341 GAIN2** subgroup (DWORD)*

534n **GAIN2n** (DWORD), n=1..8

It specifies the values of position control loop gain of the eight revolution ranges, when the second spindle position control loop is closed. The spindle encoder must be mounted on the

axis of the spindle.See parameter 4021 GAIN of SERVO parameter group for interpretation.

***5361 ACC1** subgroup (WORD)*

536n **ACC1n** (WORD), n=1..8
It specifies the acceleration values of the eight revolution ranges, when the first spindle position control loop is closed. See parameter 4701 ACC of SERVO parameter group for interpretation.

***5381 ACC2** subgroup (WORD)*

538n **ACC2n** (WORD), n=1..8
It specifies the acceleration values of the eight revolution ranges, when the second spindle position control loop is closed. See parameter 4701 ACC of SERVO parameter group for interpretation.

5401 SYNCHR1 subgroup (INTEGER)

5401 **SYNCHR_P1** (INTEGER)
Factor of the regulation of synchronization if spindle No. 1 is synchronized to spindle No. 2. The output signal is in proportion to the value and to the distance of the two zero pulses. Advised value: 256 – 300.

5402 **SPSHIFT1** (INTEGER)
It defines the distance required between the zero pulse of spindle No. 1 and that of spindle No. 2 in number of pulses after synchronization. It is a number with sign.

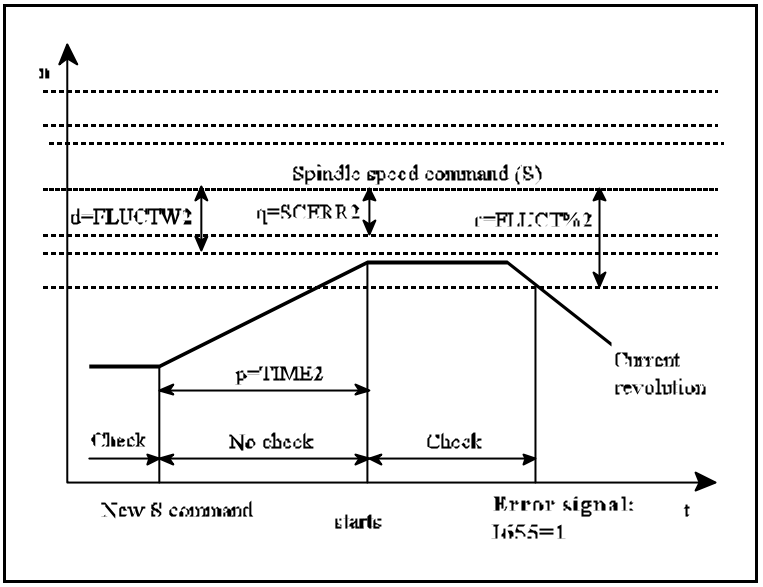
5421 SYNCHR2 subgroup (INTEGER)

5421 **SYNCHR_P2** (INTEGER)
Factor of the regulation of synchronization if spindle No. 2 is synchronized to spindle No. 1. The output signal is in proportion to the value and to the distance of the two zero pulses. Advised value: 256 – 300.

5422 **SPSHIFT2** (INTEGER)
It defines the distance required between the zero pulse of spindle No. 2 and that of spindle No. 1 in number of pulses after synchronization. It is a number with sign.

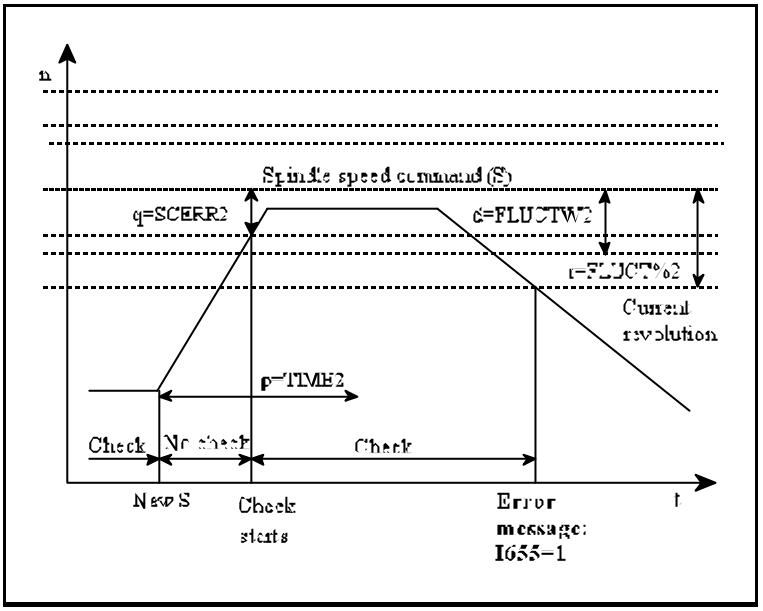
5441 FLUCT2 subgroup (WORD)

5441 **TIME2** (WORD)



Parameter for time between changes in commanded speed and check start. It is effective in state G26. Measure unit: 100 msec.
The parameter is overwritten from part program as the effect of command **G26** Pp Q R D (value of address P).
The fluctuation check starts if the revolution difference between the speed commanded and the current speed is larger than the fluctuation rate defined at parameter **SCERR2** and the interval defined on parameter **TIME2** has elapsed.

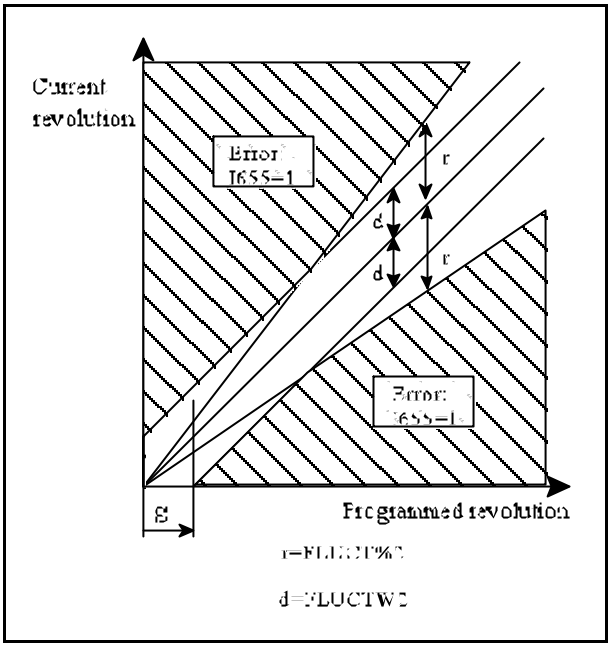
5442 **SCERR2** (WORD)



Allowable rate for starting spindle speed fluctuation check in percent. It is effective in state G26. Measure unit: %.
The parameter is overwritten from part program as the effect of command **G26** P Qq R D (value of address Q).
The fluctuation check starts if the rate of difference between the command speed and the current speed is less than the rate defined at parameter **SCERR2 before** value **TIME2** has elapsed.

5443 **FLUCT%2** (WORD)

Fluctuation rate in which an alarm is given. It is effective in state G26.
Measure unit: %.
The parameter is overwritten from part program as the effect of command **G26** P Q Rr D (value of address R).
The permissible speed fluctuation is in percent of the speed commanded.
If the current spindle revolution is out of both revolution ranges specified by parameters FLUCT%2 and FLUCTW2 after the start of fluctuation check, the control sets flag I655 to 1.



5444 **FLUCTW2** (WORD)

Parameter determining the absolute amount of spindle speed fluctuation with in which an alarm is given. It is effective in state G26. Measure unit: rev/min.
The parameter is overwritten from part program as the effect of command **G26** P Q R Dd (value of address D).
The permissible spindle speed fluctuation in absolute value.
If the current spindle speed is out of both ranges specified by parameters FLUCT%2 and FLUCTW2 after the start of fluctuation check, the control sets flag I655 to 1.

☞ *Notes:*

Parameters above mentioned are referring to the spindle No. 2 and are effective only if spindle No. 2 is active. (In case of PLC flag Y660=1.)

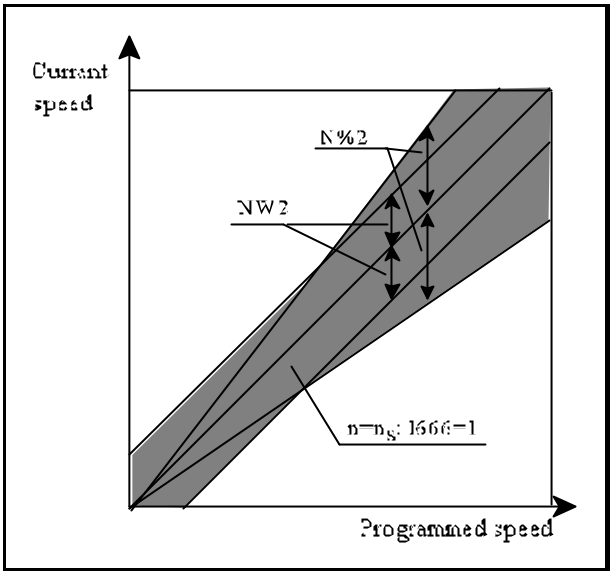
The spindle speed ranges to which the NC sets flag I655 can be seen on the diagram. If the programmed spindle speed is under value "S" seen on diagram the NC sends error signal provided the current revolution is 0 rev/min for more than 1 second.
The check of spindle speed fluctuation is only effective when encoder is mounted on spindle (parameter state ENCODERS2>0).
The speed commanded is compared to the current revolution by taking the override, speed limits belonging the spindle gear ranges and programmed maximum spindle speed (G92 S_) in the state of constant surface speed (G96) into account.
The check of revolution fluctuation is only effective in case of G26 and of rotating spindle (state M3 or M4). After power-on the NC is in state G26 (I654=0). By programming G25 the fluctuation check is canceled.
See also **Programmer's Manual** chapter **Check of Spindle Speed Fluctuation (G25, G26)**.

5445 **N%2** (WORD)

Rate in which the spindle speed reached signal $n=n_S$ (I666) is turned on.

Measure unit: %.

If the difference between the programmed (S) and the current spindle revolution is in the interval specified by parameters N%2 or NW2 the control sets flag I666 $n=n_S$ to 1.



5446 **NW2** (WORD)

Spindle speed width in which the spindle speed reached signal n=nS (I666) is turned on.

Measure unit: rev/min.

If the difference between the programmed (S) and the current spindle revolution is in the interval specified by parameters N%2 or NW2 the control sets flag I626 $n=n_S$ to 1.

5447 **N02** (WORD)

Spindle speed width in which the spindle speed reached n=0 (spindle stop) signal is turned on.

Measure unit: rev/min.

If the value of current spindle speed is in the interval specified by parameter N02 the control sends signal n=0, i.e. sets flag I667 to 1.

☞ *Notes:*

Functions $n=n_S$ and n=0 are only effective if encoder is built on the spindle (parameter state ENCODERS2>0).

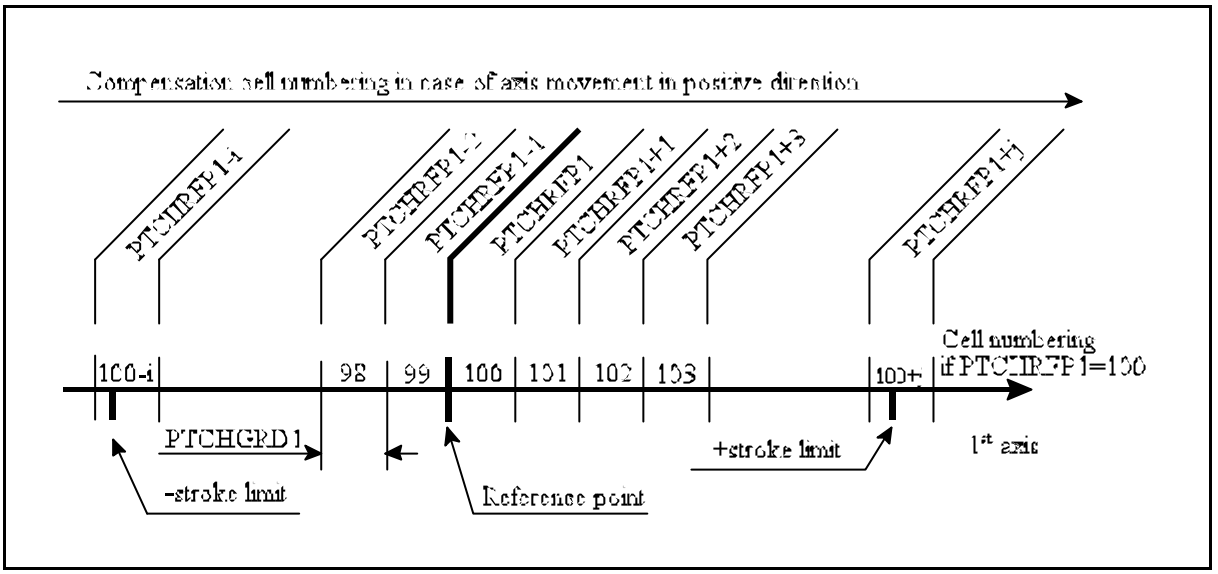
The speed commanded is compared to the current revolution by taking the override, speed limits belonging the spindle gear ranges and programmed maximum spindle speed (G92 S_) in the state of constant surface speed (G96) into account.

When the spindle is stopped both signals $n=n_S$ and n=0 (I666 and I667) are set to 1.

5.9 PTCHCMP Parameter Group

***6001 PTCHRFP** subgroup (WORD)*

600n **PTCHRFPn** (WORD), n=1..8



The value entered at this parameter shows the number of the first of 900 possible pitch error compensation cells in **positive** direction from the **reference point** on the given axis in case of **positive movement** (as well as the number of parameter PTCHVAL at which the compensation value of the cell is specified).

Thus, as in the example seen on the above diagram, provided axis X is physical axis No. 1 and

PTCHRFP1=100,

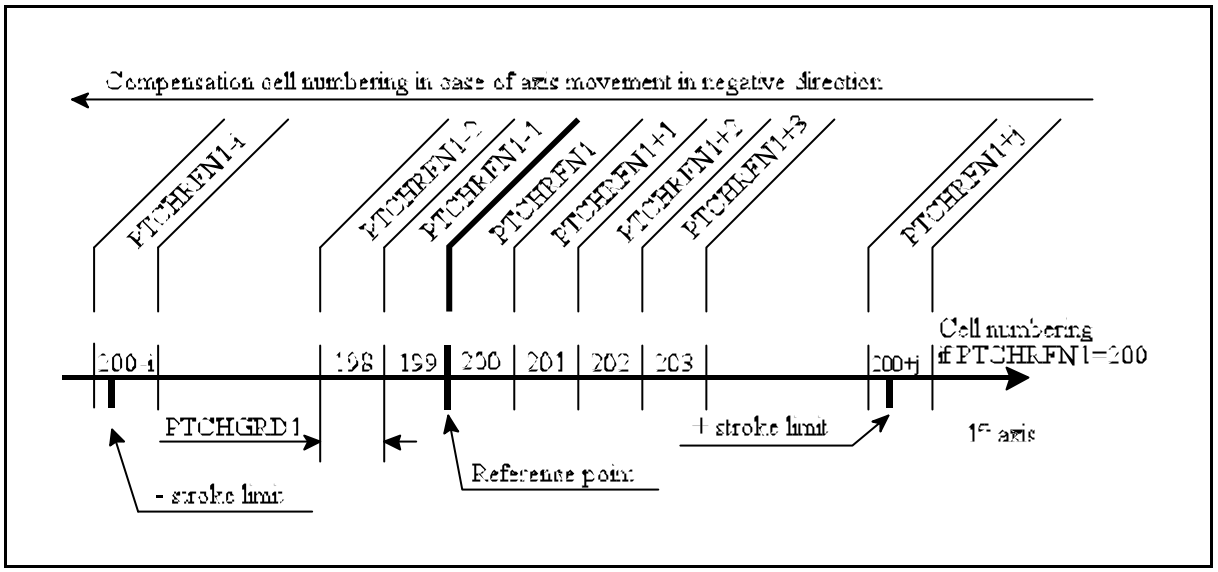
then, if movement is made from the negative stroke limit to the positive one as the cells are passed by after one another the compensation values are taken from compensation cells

PTCHVAL[100-i], ..., PTCHVAL98, PTCHVAL99, PTCHVAL100, PTCHVAL101, PTCHVAL102, PTCHVAL103, ..., PTCHVAL[100+j].

The desired value is to be entered at the parameter according to the physical axis number.

6021 PTCHRFN subgroup (WORD)

602n **PTCHRFNn** (WORD), n=1..8



The number entered at this parameter shows the number of the first of 900 possible compensation cells in **positive** direction from the **reference point** on the given axis in case of **negative movement** (as well as the number of parameter PTCHVAL at which the compensation value of the cell is specified).

Thus, as in the example seen on the above diagram, provided axis X is physical axis No.1 and

PTCHRFN1=200,

then, if movement is made from the positive stroke limit to the negative one as the cells are passed by after one another the compensation values are taken from compensation cells

PTCHVAL[200+j], ..., PTCHVAL203, PTCHVAL202, PTCHVAL201, PTCHVAL200, PTCHVAL199, PTCHVAL198, ..., PTCHVAL[200-i].

The desired value is to be entered at the parameter according to the physical axis number.

☞ *Notes:*

There is no need to register different compensation values in case of positive and negative movements. If

PTCHRFPn=PTCHRFNn,

then the same values are taken into account by the control in both directions on the n^{th} *axis.*

6041 PTCHGRD subgroup (WORD)

604n **PTCHGRDn** (WORD), n=1..8

Width of compensation cell, i.e. axis movement between two compensation positions in **mm** or **inch** depending on parameter **INCH DET**. The desired value must be given at the parameter according to the physical axis number. If e.g.. PTCHGRD1=10 this means, that the compensation cell width on physical axis No. 1 is 10 mm, provided INCH DET=0, i.e. the measure system is metric.

***6061 PTCHEN** subgroup (BIT)*

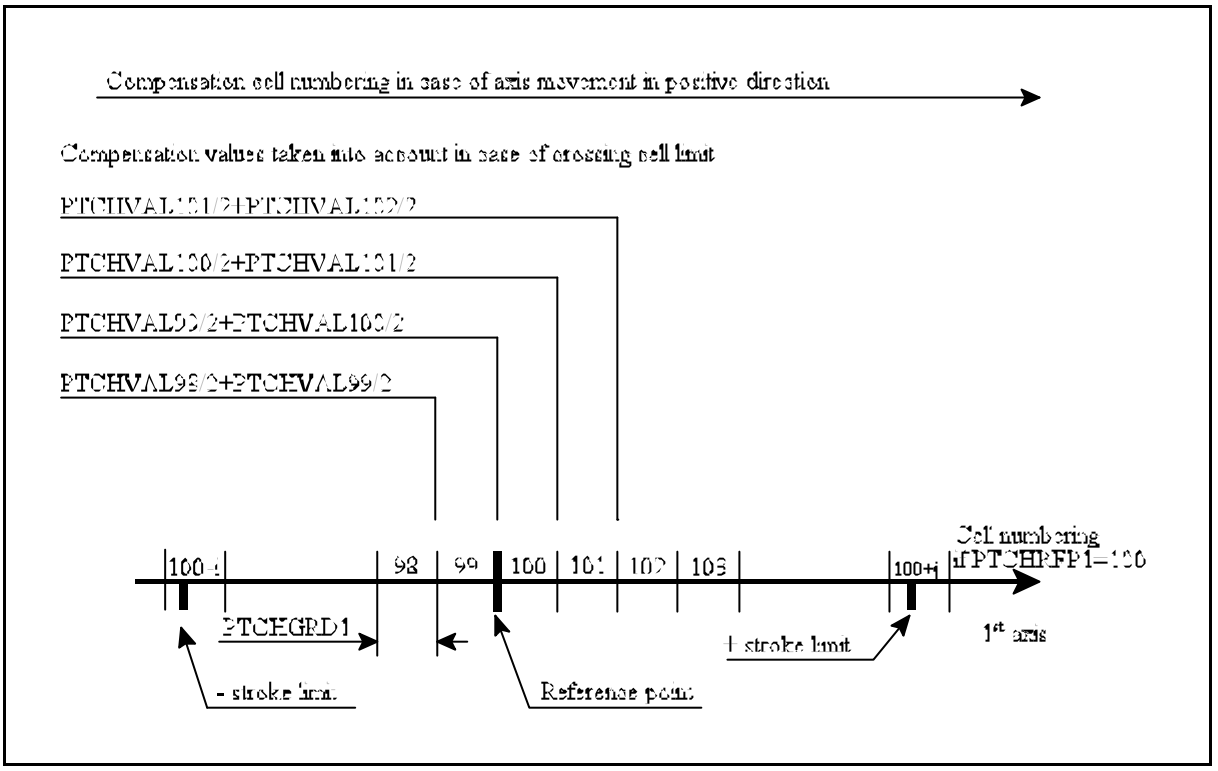
606n **PTCHENn** (BIT), n=1..8

Enabling compensation on the given axis.

0: there is no compensation on the given axis,

1: there is compensation on the given axis.

***6081 PTCHVAL** subgroup (SHORTINT)*

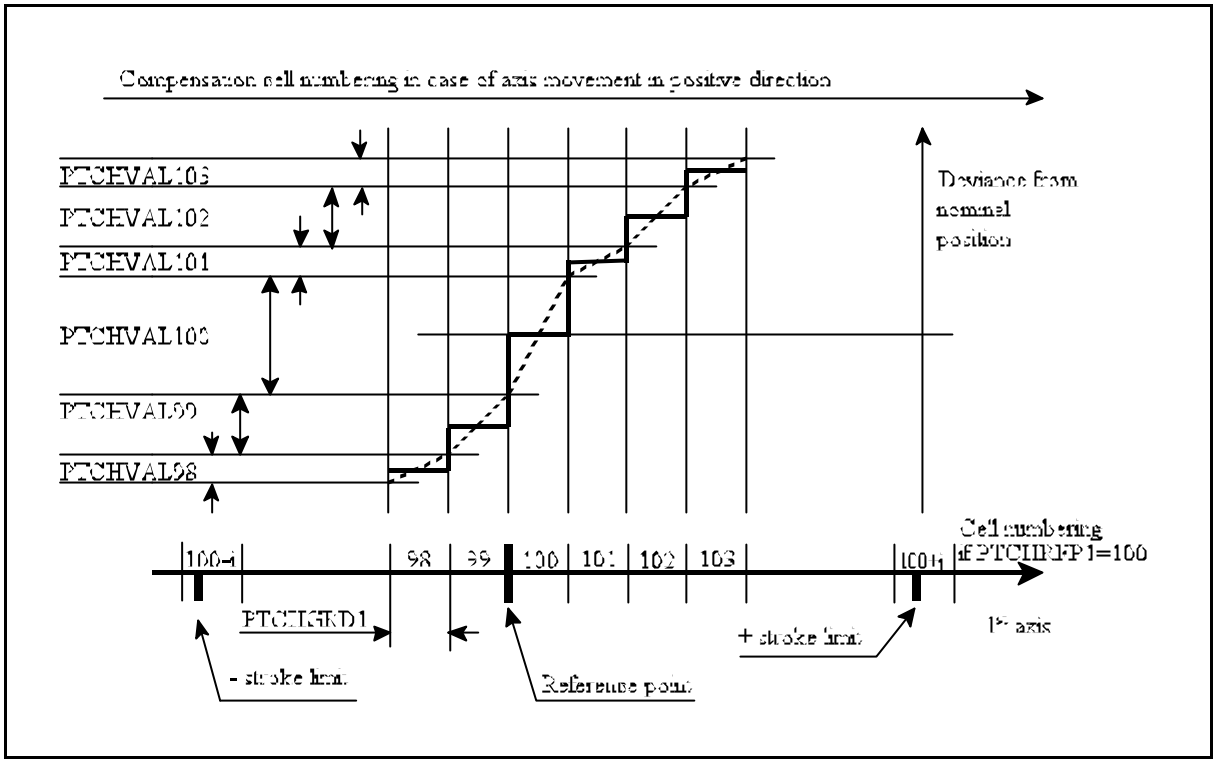


6nnn **PTCHVALi** (SHORTINT), n=081..980, i=1...900

The compensation value of the given cell number in output increment. The pitch error compensation values must be in the value range of –127, ... +127.
As seen on the diagram when passing the limit of two neighboring cells it adds half of the compensation value of the cell to half of the compensation value of the previous cell.
The resulted compensation values are added algebraically for each axis one by one in both directions. For the result the following value limit is valid:

$$-32768 \le \sum_{n=1}^{i} PTCHVAL_n \le 32767$$

As seen in the above relation the maximum compensation distance is approximately. ±16 mm in each direction provided the measuring system is metric and the resolution is 0.001 mm.

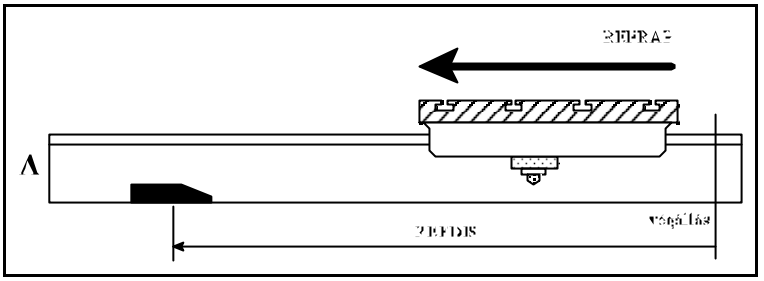


In the above diagram the **dashed line** indicates the deviation from the nominal position. The difference of the deviation from the nominal size measured at the start and end of cell is entered into cell PTCHVALn .
In the diagram **the thick stepped line** shows that when passing the limit of two neighboring cells it adds half of the compensation value of the cell to half of the compensation value of the previous cell. The control approaches the error curve with the help of this method.

5.10 REFPAR Parameter Group

7001 REFDIS subgroup (INTEGER)

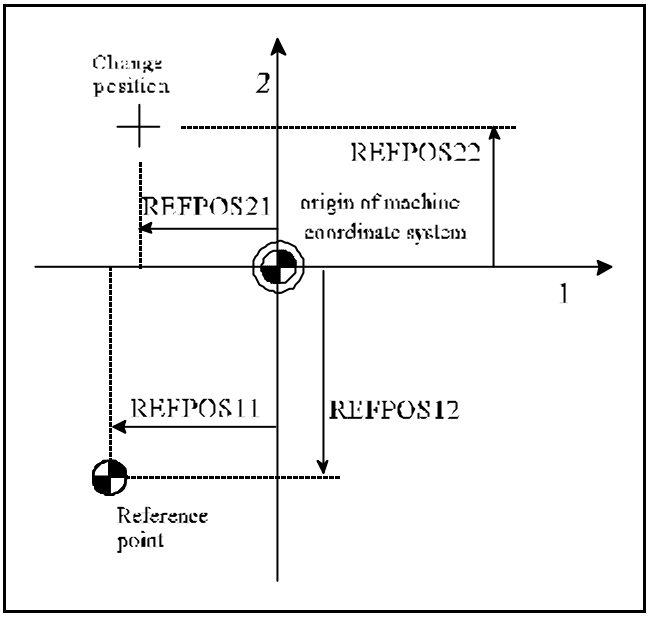
700n **REFDISn** (INTEGER), n=1..8
7009 **REFDISS1** (INTEGER)
7010 **REFDISS2** (INTEGER)



The path of reference point search on the 1st ..8th axes in case of MACHINE's reference point return. The signed distance, at which the axis concerned is located from the deceleration switch in the instant of starting the machine's reference point return has to be specified. The control searches for the deceleration switch in the direction defined by the parameter sign and expects to run across the switch within the specified distance. If reference point return is to be initiated from all positions of the axis then the stroke of the axis must be specified. Unless the switching signal is received, the control sends error message *REFPONT t1 No. 1100 ... 1170*, where t is the logic name of the given axis, e.g.: X.
Measure unit: input increment.
Parameters REFDISS1, REFDISS2 are out of use.

7021 REFPOS1 subgroup (LONGINT)

702n **REFPOS1n** (LONGINT), n=1..8
7029 **REFPOS1S1** (LONGINT)
7030 **REFPOS1S2** (LONGINT)



Location of the reference point set upon the zero pulse of the encoder, in the machine coordinate system (G53). In part program the control runs upon this position as he effect of command G28 XI0 YI0 ....
Measure unit: input increment.

7041 REFPOS2 subgroup (LONGINT)

704n **REFPOS2n** (LONGINT), n=1..8
7049 **REFPOS2S1** (LONGINT)
7050 **REFPOS2S2** (LONGINT)

Location of the second reference point in the machine coordinate system. It has nothing to do with the reference point return; they are fixed positions selected on the machine, e.g. position of pallet change etc. In part program the control runs upon this position as he effect of command G30 P2 XI0 YI0 ....
Measure unit: input increment.

7061 REFPOS3 subgroup (LONGINT)

706n **REFPOS3n** (LONGINT), n=1..8
7069 **REFPOS3S1** (LONGINT)
7070 **REFPOS3S2** (LONGINT)

Position of the third reference point in the machine coordinate system. It has nothing to do with the reference point return; they are fixed positions selected on the machine, e.g. position of pallet change etc. In part program the control runs upon this position as he effect of command G30 P3 XI0 YI0 ....
Measure unit: input increment.

7081 REFPOS4 subgroup (LONGINT)

708n **REFPOS4n** (LONGINT), n=1..8
7089 **REFPOS4S1** (LONGINT)
7090 **REFPOS4S2** (LONGINT)

Position of the fourth reference point in the machine coordinate system. It has nothing to do with the reference point return; they are fixed positions selected on the machine, e.g. position of pallet change etc. In part program the control runs upon this position as he effect of command G30 P4 XI0 YI0 ....
Measure unit: input increment.

7101 REFRAP subgroup (WORD)

710n **REFRAPn** (WORD), n=1..8
7109 **REFRAPS1** (WORD)
7110 **REFRAPS2** (WORD)

Rate of running to the deceleration switch in case of machine reference point return (MACHINE). Before machine reference point return the software stroke limits are generally not active yet. Accordingly, it should be remembered that, in the event of a trouble, the slide will run to the emergency stroke limit without slowing down; it must be stopped before the mechanical impact occurs.
Measure unit: mm/min, inch/min, or deg/min.
Parameters REFRAPS1, REFRAPS2 are out of use.

***7121 REFEED** subgroup (WORD)*

712n **REFEEDn** (WORD), n=1..8
7129 **REFEEDS1** (WORD)
7130 **REFEEDS2** (WORD)

Rate of coming down from the deceleration switch and of zero pulse search in case of machine reference point return (MACHINE), while it is the reference point return rate in case of grid (GRID) and distance coded (DISCODED) reference point return. The path between the stop after coming down from the switch and the switch position must not exceed 10 % of the distance between two zero pulses (**ZERODISn**). To this end, the usual "rule of thumb" is that $REFEED_n \left[\frac{mm}{min}\right] = \frac{ZERODIS_n}{10} [\mu m]$.

Its measure unit: mm/min, inch/min, or deg/min.
Parameters REFEEDS1, REFEEDS2 are used by the NC if reference point offset is given at parameter REFSHIFTS1, or REFSHIFTS2. In this case the number written at the appropriate parameter REFEEDSn specifies the rate, at which offset is executed. Interpretation of the rate is as follows:

$$REFEEDS1 = \frac{4 \cdot ENCODERS1}{12000} \cdot n$$

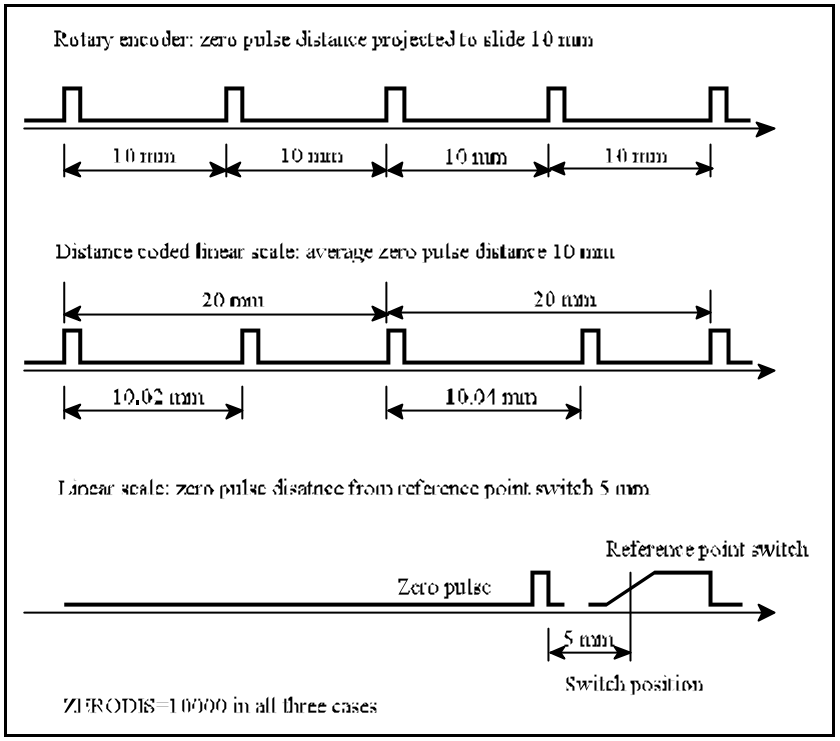
where n: revolution of the desired spindle in $\frac{rev}{min}$ and

ENCODERS1: resolution of the spindle encoder

If for example 1024-resolution-encoder is mounted on the spindle and 3 $\frac{rev}{min}$ is to be set REFEEDS1 must be 1.

7141 ZERODIS subgroup (WORD)

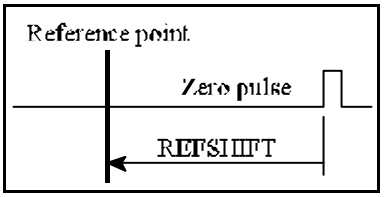
714n **ZERODISn** (WORD), n=1..8
7149 **ZERODISS1** (WORD)
7150 **ZERODISS2** (WORD)



The distance between two zero pulses in case of rotary encoder projected to slide.
In case of distance coded linear scales the average distance between two consecutive zero pulses.
In case of non-distance-coded linear scale if machine reference point return (MACHINE) is applied it is the double of the distance between the deceleration switch and the zero pulse
In case of spindle value 4*ENCODERS1(2) must be entered at parameter ZERODISS1, 2.
Measure unit: input increment

7161 REFSHIFT subgroup (INTEGER)

716n **REFSHIFTn** (INTEGER), n=1..8
7169 **REFSHIFTS1** (INTEGER)
7170 **REFSHIFTS2** (INTEGER)



Reference point shift.
If, for any reason, the absolute location of the machine reference point is accurately fixed, this position can be set with this parameter without the physical shift of zero pulse. As a result, after the zero pulse has been found, the axis will also cover the distance written at this parameter in the direction defined by its sign and at rate **REFEED.**
Its measure unit in case of REFSHIFT1..8: input increment.
On spindle parameter REFSHIFTS1,2 comes into effect when the execution of M19 is over. Its measure unit is encoder division, i.e. 4*ENCODERS1(2) belongs to 360 deg movement.

7181 REFDIR subgroup (BIT)

718n **REFDIRn** (BIT), n=1..8
7189 **REFDIRS1** (BIT)
7190 **REFDIRS2** (BIT)

Direction of coming down from the switch in case of MACHINEn=1, as well as direction of zero pulse search in case of GRIDn=1 and DISCODEDn=1.
0: coming down from the switch in negative direction.
1: coming down from the switch in positive direction.

7201 ZPULS subgroup (BIT)

720n **ZPULSn** (BIT), n=1..8
7209 **ZPULSS1** (BIT)
7210 **ZPULSS2** (BIT)

Machine reference point return (MACHINE=1) with or without zero pulse.
0: end of reference point return upon detection of coming down from the switch.
1: end of reference point return upon detection of zero pulse after the come-down.
In case of spindles:
0: first orientation after turning the power on (M19) happens by searching the zero pulse the others by positionong to the reference position,
1: all orientations happen by searching the zero pulse.

7221 SWLENGTH subgroup (DWORD)

722n **SWLENGTHn** (DWORD), n=1..8
7229 **SWLENGTHS1** (DWORD)
7230 **SWLENGTHS2** (DWORD)

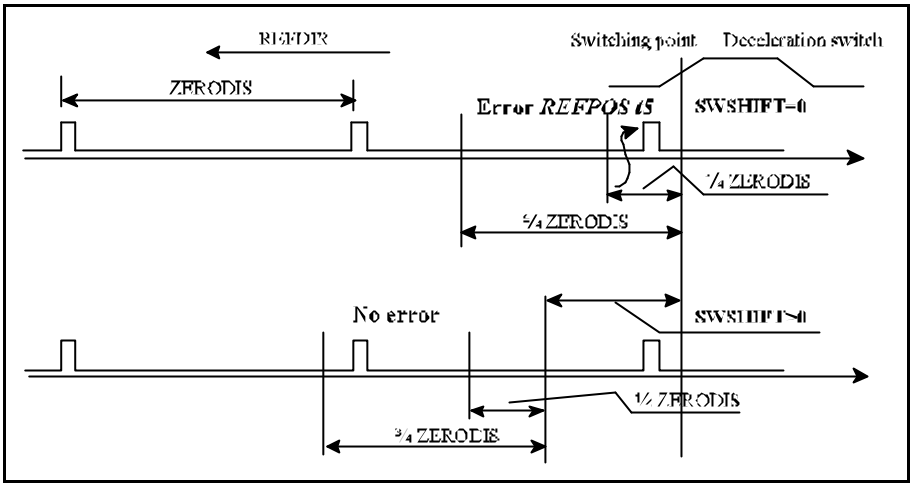
Length of the deceleration switch. If the slide finishes the distance determined here after running to switch and the switch signal is still active error message *Reference point t2 No. 1101 ... 1171* is sent by the control
Measure unit: input increment.

7241 SWSHIFT subgroup (DWORD)

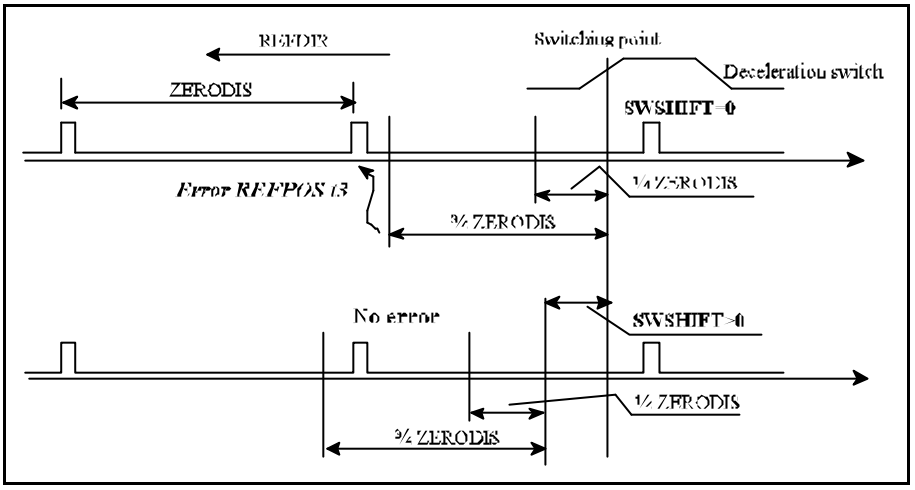
724n **SWSHIFTn** (DWORD), n=1..8
7249 **SWSHIFTS1** (DWORD)
7250 **SWSHIFTS2** (DWORD)

Shift of **deceleration switch** in input increment in case of **machine reference point return** (MACHINE)**.** The zero pulse search is started after the distance given at parameter has been covered. The distance is covered by the control with speed REFRAPn.
This parameter is needed if the zero pulse is close to the deceleration switch and it might take once this zero pulse, another time the next one into account when setting reference point due to the unsure switch. The above are automatically detected by the control.

If the zero pulse is in the distance of SWSHIFTn+ 3 ZERODISn after coming down from the switch error message *Reference point t5 No. 1104 ... 1174* is sent by the control.



If the zero pulse is over the distance of SWSHIFTn+ : ZERODISn after coming down from the switch error message *Reference point t3 No. 1102 ... 1172 is sent by the control.*



In case of **distance coded reference point return** the value entered here shows the **distance** in input increment, **over** which **two zero pulses** are regarded as **different ones**.

***7261 REFTYPE1** subgroup (BIT)*

7261 **MACHINE1** (BIT)
7262 **FLOAT1** (BIT)
7263 **GRID1** (BIT)
7264 **DISCODED1** (BIT)

The type to be selected must be set to 1.

***7281 REFTYPE2** subgroup (BIT)*

7281 **MACHINE2** (BIT)
7282 **FLOAT2** (BIT)
7283 **GRID2** (BIT)
7284 **DISCODED2** (BIT)
The type to be selected must be set to 1.

***7301 REFTYPE3** subgroup (BIT)*

7301 **MACHINE3** (BIT)
7302 **FLOAT3** (BIT)
7303 **GRID3** (BIT)
7304 **DISCODED3** (BIT)
The type to be selected must be set to 1.

***7321 REFTYPE4** subgroup (BIT)*

7321 **MACHINE4** (BIT)
7322 **FLOAT4** (BIT)
7323 **GRID4** (BIT)
7324 **DISCODED4** (BIT)
The type to be selected must be set to 1.

***7341 REFTYPE5** subgroup (BIT)*

7341 **MACHINE5** (BIT)
7342 **FLOAT5** (BIT)
7343 **GRID5** (BIT)
7344 **DISCODED5** (BIT)
The type to be selected must be set to 1.

***7361 REFTYPE6** subgroup (BIT)*

7361 **MACHINE6** (BIT)
7362 **FLOAT6** (BIT)
7363 **GRID6** (BIT)
7364 **DISCODED6** (BIT)
The type to be selected must be set to 1.

***7811 REFTYPE7** subgroup (BIT)*

7811 **MACHINE7** (BIT)
7812 **FLOAT7** (BIT)
7813 **GRID7** (BIT)
7814 **DISCODED7** (BIT)
The type to be selected must be set to 1.

7401 REFTYPE8 subgroup (BIT)

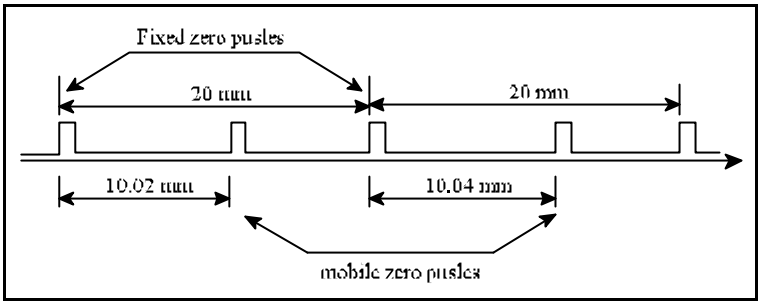
7401 **MACHINE8** (BIT)
7402 **FLOAT8** (BIT)
7403 **GRID8** (BIT)
7404 **DISCODED8** (BIT)

The type to be selected must be set to 1.

7421 BASDIST subgroup (WORD)

724n **BASDISTn** (WORD) n=1..8

It must be specified in case of distance coded linear scales. Meaning of parameter: distance of fixed zero pulses in function of the signal period of the scale.



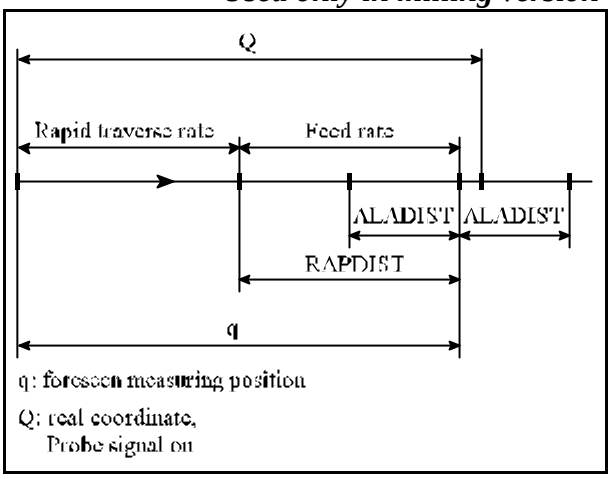
Heidenhain type	Distance of fixed zero pulses in mm	Signal period of the scale in mm	**BASDISTn**
LF	20 mm	0.004 mm	20/0.004=5000
LS	20 mm	0.020 mm	20/0.020=1000
LB	80 mm	0.040 mm	80/0.040=2000

5.11 MEASURE Parameter Group

***8001 MEASDIST** subgroup (LONGINT)*

8001 **RAPDIST** (LONGINT) ***Used only in milling version***

In command G37 Zq the distance measured from the end position coordinate entered at the parameter is subtracted (q - *RAPDIST*) and the axis runs at rapid traverse rate to this position. The distance is interpreted in input increment system..



8002 **ALADIST** (LONGINT)

Used only in milling version

If the probe signal is not detected within the tolerance interval which is measured from the programmed end position in command G37 Zq specified at the parameter, i.e. if |Q)q|>ALADIST then error message *OUT OF RANGE* No. *3103* is sent.

8001 **RAPDISTX** (LONGINT) ***Used only in lathe version***

In command G36 Xq the distance measured from the end position coordinate entered at the parameter is subtracted (q - *RAPDIST*) and the axis runs at rapid traverse rate to this position. The distance is interpreted in input increment system..

8002 **ALADISTX** LONGINT) ***Used only in lathe version***

If the probe signal is not detected within the tolerance interval which is measured from the programmed end position in command G36 Xq specified at the parameter, i.e. if |Q)q|>ALADIST then error message *OUT OF RANGE* No. *3103* is sent.

8003 **RAPDISTZ** (LONGINT) ***Used only in lathe version***

In command G37 Zq the distance measured from the end position coordinate entered at the parameter is subtracted (q - *RAPDIST*) and the axis runs at rapid traverse rate to this position. The distance is interpreted in input increment system..

8004 **ALADISTZ** (LONGINT) ***Used only in lathe version***

If the probe signal is not detected within the tolerance interval which is measured from the programmed end position in command G37 Zq specified at the parameter, i.e. if |Q)q|>ALADIST then error message *OUT OF RANGE* No. *3103* is sent.

***8021 MEASFD** subgroup (WORD)*

8021 **G31FD** (WORD)

Feed rate used during the execution of command G31 interpreted in the whole part of output measure system. If =1 it means 1 mm/min or 1 inch/min.

8022 **G37FD** (WORD)

Feed rate used during the execution of command G37 (command G36 and G37 on lathe control) interpreted in the whole part of output measure system. If =1 it means 1 mm/min or 1 inch/min.

On lathe control the feedrate of slides in case of pressing jog buttons in switched-on state of automatic tool length measure (Y426=1) when tool offset measureing sensors.

8023 **BCKDIST** (WORD)

Not used.

***8041 MEASCS** subgroup (BYTE)*

8041 **G31BIT** (BYTE)

The parameter shows the pin of CPU board connector P1 on which the probe signal of command G31 appears. The correspondence between the parameter value and the connection is as follows:

G31BIT=0) P1/1; P1/9
G31BIT=1) P1/2; P1/10
G31BIT=2) P1/3; P1/11
G31BIT=3) P1/4; P1/12

This parameter is used only if address P is not used in block G31. If it is used address P assignes which skip signal input is used idependently of parameter G31BIT.:

G31... P1=P1/1; P1/9
G31... P2=P1/2; P1/10
G31... P2=P1/3; P1/11
G31... P4=P1/4; P1/12

8042 **G37BIT** (BYTE)

The parameter shows the pin of CPU board connector P1 on which the probe signal of command G37 appears. The correspondence between the parameter value and the connection is as follows:

G37BIT=0) P1/1; P1/9
G37BIT=1) P1/2; P1/10
G37BIT=2) P1/3; P1/11
G37BIT=3) P1/4; P1/12

8043 **SKIPCS** (BYTE)

Not used.

***8061 MEAS** subgroup (BIT)*

8061 **UPG31** (BIT)

Not used.

8062 **UPG37** (BIT)

Not used.

8063 **SKIPF** (BIT)

If =0 feed of command G31 is taken from the program.

If =1 feed of command G31 is taken from parameter *G31FD*.

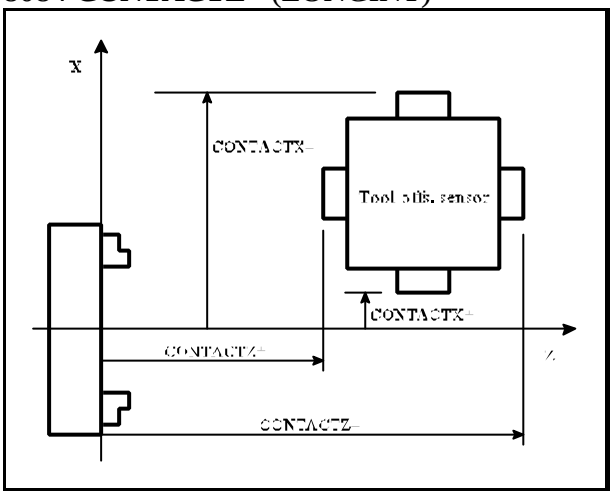
*If the NCT measuring and digitalizing programs are used this parameter must be set to **0**.*

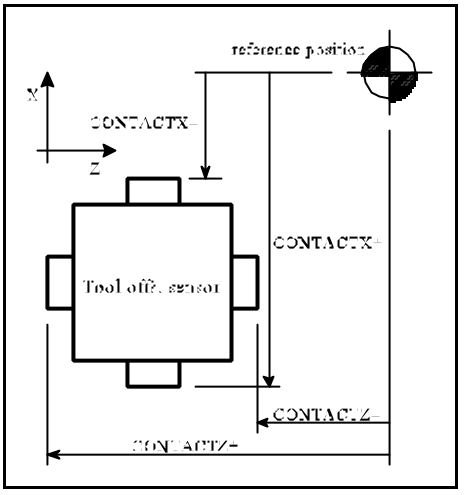
8064 **ADD** (BIT)

If =0 the measured value is subtracted from,
if =1 the measured value is added to the current wear value in command G36, G37.

8081 CONTACT** subgroup (LONGINT)* ***Used only in lathe version

8081 **CONTACTX+** (LONGINT)
8082 **CONTACTX–** (LONGINT)
8083 **CONTACTZ+** (LONGINT)
8084 **CONTACTZ–** (LONGINT)





Parameters locating the direction buttons of the tool offset sensor in case of automatic tool length measure. The distance of buttons can be based on (measured to) the chuck coordinate system as well as the reference point.
In the switched-on state of automatic tool length compensation (Y426=1), as the effect of flags Y580, ..., Y583 coming from the PLC, the NC takes the parameter belonging to the given flag into account when defining length offset in the appropriate direction. Comparisons between flags and parameters:

Y580) CONTACTX+
Y581) CONTACTX–
Y582) CONTACTZ+
Y583) CONTACTZ–

5.12 MACRO Parameter Group

***9001 TIMERS** subgroup (DWORD)*

9001 **POWERON1** (DWORD)
Msec part of 32-bit timer of power-on period.
9002 **POWERON2** (DWORD)
Minute part of 32-bit timer of power-on period.
☞ *Parameters POWERON1 and POWERON2 are set to the value of POWER ON TIME line TIMER/COUNTER screen SETTING menu.*
9003 **OPERAT1** (DWORD)
Msec part of 32-bit timer of time spent in AUTOMATIC operation mode.
9004 **OPERAT2** (DWORD)
Minute part of 32-bit timer of time spent in AUTOMATIC operation mode .
☞ *Parameters OPERAT1 and OPERAT2 are set to the value of OPERATING TIME line TIMER/COUNTER screen SETTING menu.*
9005 **CUTTING1** (DWORD)
Msec part of 32-bit cutting timer.
9006 **CUTTING2** (DWORD)
Minute part of 32-bit cutting timer. It can be also called through macro variable #3002.
☞ *Parameters CUTTING1 and CUTTING2 are set to the value of CUTTING TIME line TIMER/COUNTER screen SETTING menu.*
9007 **FREEPUR1** (DWORD)
Msec part of 32-bit free purpose timer.
9008 **FREEPUR2** (DWORD)
Minute part of 32-bit free purpose timer.
☞ *Parameters FREEPUR1 and FREEPUR2 are set to the value of FREE PURPOSE line TIMER/COUNTER screen SETTING menu.*

***9021 COUNTERS** subgroup (DWORD)*

9021 **PRTTOTAL** (DWORD)

32-bit counter for all parts done. It can be displayed through macro variable #3901. If parameter PRTCNTM =0 every command M02 or M30 adds one to the counter value, if however parameter PRTCNTM >0 code M, the number of which is written at the parameter, increments the counter content.

☞ *Parameter PRTTOTAL is set to the value of PARTS TOTAL line TIMER/COUNTER screen SETTING menu.*

9022 **PRTCOUNT** (DWORD)

32-bit counter, for machining parts count of series. If parameter PRTCNTM =0 every command M02 or M30 adds one to the counter value, if however parameter PRTCNTM >0 code M, the number of which is written at the parameter, adds to the counter content.

☞ *Parameter PRTCOUNT is set to the value of PARTS COUNT line TIMER/COUNTER screen SETTING menu.*

9023 **PRTREQRD** (DWORD)

32-bit counter, for requesting parts count of series. It can be displayed through macro variable #3902.

☞ *Parameter PRTREQRD is set to the value of PARTS REQUIRED line TIMER/COUNTER screen SETTING menu.*

9024 **PRTCNTM** (DWORD)

=0: 1 is added to counter PRTTOTAL and PRTCOUNT (PARTS TOTAL and PARTS COUNT) as an effect of commands M2 and M30,
other than 0: code M increments the parts counter.

***9041 GMACRO** subgroup (INTEGER)*

9041 **G(9010)**

User code G calling user macro No. O9010.

9042 **G(9011)**

User code G calling user macro No. O9011.

.

.

9050 **G(9019)**

User code G calling user macro No. O9019.
Values from –1000 to (+)1000 (–1000, –999, –1, 0, 1, 999, 1000) can be entered at the parameter. If **negative** number has been written at the parameter the call of the macro selected for code G is **modal**. The state of parameter **MODGEQU** specifies, whether the type of call is G66 or G66.1. If **1000 or –1000** has been entered at the parameter the macro with the appropriate number is called at code **G0**. If 0 has been written at the parameter the macro is not called..

***9061 MMACRO** subgroup (WORD)*

9061 **M(9020)**
User code M calling user macro No. O9020.
9062 **M(9021)**
User code M calling user macro No. O9021.
.
.
9070 **M(9029)**
Code M calling macro No. O9029.
The parameter is followed by a number of maximum three digits with the value range of 1-999. The meaning of the value of parameter: it selects the code M calling the user macro indicated in the parameter identity.
For example, if the value of parameter M(9020) is 8, command M08 executes macro No. O9020.

☞ *Noted*: The macro call to the selected code M transfers all addresses in block as arguments to the macro group through macro variables #1, ... #33. Therefore if there is no need for argument transfer command M must be selected for subprogram call, otherwise unexpected function may emerge. See also parameters **MSUBPRG**.

***9081 MSUBPRG** subgroup (WORD)*

9081 **M(9000)**
User code M calling subprogram No. O9000.
9082 **M(9001)**
User code M calling subprogram No. O9001.
.
.
9090 **M(9009)**
User code M calling subprogram No. O9009.
The parameter is followed by a number of maximum three digits with the value range of 1-999. The meaning of the value of parameter: it selects the code M calling the subprogram indicated in the parameter identity.
For example, if the value of parameter M(9000) is 8, command M08 calls subprogram No. O9000.

☞ *Note*: ***MMACRO** has a similar function, except that it is also possible for the called program to transfer parameters in case of macro call.*

***9101 WRPROT** subgroup (WORD)*

9101 **WRPROT1** (WORD)
9102 **WRPROT2** (WORD)
Macro variables from #500 to #599 can be protected from writing with the help of parameters **WRPROT1** and **WRPROT2**. At parameter **WRPROT1** the first item of the macro array to be protected, while at parameter **WRPROT2** the last item of the protected macro array should be entered.

For example; if the macros from #530 to #540 are to be protected from writing parameters must be set as **WRPROT1**=530 and **WRPROT2**=540. If after all a protected variable is to be overwritten error message # DEFINITION PROHIBITED No. 3090 is sent by the control.

***9121 ABCST** subgroup (BIT)*

9121 **A(9030)** (BIT)
9122 **B(9031)** (BIT)
9123 **C(9032)** (BIT)
9124 **S(9033)** (BIT)
9125 **T(9034)** (BIT)

If the parameter is set to 1 the appropriate address generates the call of subprogram, the number of which is indicated in the parenthesis. Values of the calling address are also transferred to the subprogram through the following variables:

A) #195
B) #196
C) #197
S) #198
T) #199

9126 **FGMAC** (BIT)

SQ call of user code G called from user call M, S, T, A, B, C, as well as
SQ enabling or disabling the user call M, S, T, A, B, C initiated from user code G depending on the state of parameter **FGMAC**.

0: disabled (executed as simple codes M, S, ... G),
1: enabled.

Example: let

G101 be user code: 9042 G(9011)=101;
M06 be user code calling subprogram: 9081 M(9000)=6.
If command M6 is called in program O9011 the conclusion:

FGMAC=0

```
%O9011(G101)
...
M06 (code 06 is transferred to
PLC)
...
M99
%
```

FGMAC=1

```
%O9011(G101)
...
M06 calls subprogram O9081)
...
M99
%
```

9127 **SMSDIS** (BIT)

0: **reads system macros** from O9000 to O9034 and gathers the necessary movements and functions in the course of block search.

1: **does not read system macros** from O9000 to O9034 and thus does not gather any movements or function in the course of block search.

Example: let address B be selected for subprogram call: 9122 B(9031)=1. The subprogram:

```
%O9031(B)
M50          (unclamp rotary table)
G0 B#196     (position table)
M51          (clamp rotary table)
M99
%
```

SMSDIS=0

```
%O0123
G0 X100 Y50
B0
M3 S100
Z20 (search for this block)
...
```

Gathered commands:

```
M3 S100
M50 M51
```

M50, M51 are gathered

SMSDIS=1

```
%O0123
G0 X100 Y50
B0
M3 S100
Z20 (search for this block)
...
```

Gathered commands:

```
M3 S100
```

M50, M51 are not gathered.

***9141 MACROCON** subgroup (BIT)*

9141 **MODGEQU** (BIT)

If a user code G is given with **negative** sign at parameters 9041 G(9010), ..., 9050 G(9019), then it is selected for modal code. Afterwards the following alternatives are offered at parameter MODEQU:

0: the type of user modal call G is G66, i.e. the macro is called after every movement command execution, or

1: the type of user modal call G is G66.1, i.e. interprets every block as argument selection and the macro is called with their parameters.

9142 **CLCV** (BIT)

0: global variables from #100 to #119 are not cleared upon reset.

1: global variables from #100 to #119 are cleared upon reset..

9143 **PRNT** (BIT)

In the course of execution of macro command **DPRNT** (decimal data output) during transfer through serial bus (POPEN1 opens it), or to memory (POPEN31 opens it) if the parameter is

0: **space** code is transferred in the place of sign + and the leading zeros, after decimal point, if there is, every zero is transferred with code 0.

1: sign + and the leading zeros are not transferred, if the decimal digit has been defined the zeros following are transferred, if the decimal digit has not been defined neither the decimal digit nor zeros are transferred.

Example:

```
DPRNT [ X#130 [53] Y#500 [53] T#10 [2] ]
   #130=35.897421       S))Q   35.897
   #500=-150.8          S))Q   -150.8
   #10=214.8            S))Q   15
```

Data transfer in case **PRNT**=0:

```
7 6 5 4 3 2 1 0
))))))))))))))
1 1 0 1 1 0 0 0  --- X
1 0 1 0 0 0 0 0  --- space
1 0 1 0 0 0 0 0  --- space
1 0 1 0 0 0 0 0  --- space
1 0 1 0 0 0 0 0  --- space
0 0 1 1 0 0 1 1  --- 3
0 0 1 1 0 1 0 1  --- 5
0 0 1 0 1 1 1 0  --- decimal point (.)
1 0 1 1 1 0 0 0  --- 8
0 0 1 1 1 0 0 1  --- 9
1 0 1 1 0 1 1 1  --- 7
0 1 0 1 1 0 0 1  --- Y
0 0 1 0 1 1 0 1  --- negative sign (-)
1 0 1 0 0 0 0 0  --- space
1 0 1 0 0 0 0 0  --- space
1 0 1 1 0 0 0 1  --- 1
0 0 1 1 0 1 0 1  --- 5
0 0 1 1 0 0 0 0  --- 0
0 0 1 0 1 1 1 0  --- decimal point (.)
1 0 1 1 1 0 0 0  --- 8
0 0 1 1 0 0 0 0  --- 0
0 0 1 1 0 0 0 0  --- 0
1 1 0 1 0 1 0 0  --- T
1 0 1 0 0 0 0 0  --- space
1 0 1 1 0 0 0 1  --- 1
0 0 1 1 0 1 0 1  --- 5
0 0 0 0 1 0 1 0  --- line forward (LF)
```

Data transfer in case **PRNT**=1:

```
7 6 5 4 3 2 1 0
))))))))))))))
1 1 0 1 1 0 0 0  --- X
0 0 1 1 0 0 1 1  --- 3
0 0 1 1 0 1 0 1  --- 5
0 0 1 0 1 1 1 0  --- decimal point (.)
1 0 1 1 1 0 0 0  --- 8
0 0 1 1 1 0 0 1  --- 9
1 0 1 1 0 1 1 1  --- 7
0 1 0 1 1 0 0 1  --- Y
0 0 1 0 1 1 0 1  --- negative sign (-)
1 0 1 1 0 0 0 1  --- 1
0 0 1 1 0 1 0 1  --- 5
0 0 1 1 0 0 0 0  --- 0
0 0 1 0 1 1 1 0  --- decimal point (.)
1 0 1 1 1 0 0 0  --- 8
0 0 1 1 0 0 0 0  --- 0
0 0 1 1 0 0 0 0  --- 0
1 1 0 1 0 1 0 0  --- T
1 0 1 1 0 0 0 1  --- 1
0 0 1 1 0 1 0 1  --- 5
0 0 0 0 1 0 1 0  --- line forward (LF)
```

9161 SBDSP subgroup (BIT)

9161 **SBSTM** (BIT)

Parameter controlling NC and macro block execution. NC block contains movement command and function.

Macro blocks:

SQ definition, substitution command: #i=#j

SQ divergence or iteration command: IF, WHILE

SQ blocks containing control command: GOTO, DO, END

SQ blocks containing macro call: G65, G66, G66.1, G67, or codes G or M starting macro call.

– subprogram calls (subprogram started with M98 P or A, B, C, S, T, M)

If the parameter

=0: the NC and macro blocks are executed as written in program,

=1: macro commands are executed during NC block execution.

Example:

SBSTM =0

```
%O1000
...
N10 #100=50
N20 #101=100
N30 G1 X#100 Y#101
N40 #100=60 (definition after N30)
N50 #101=120 (definition after N30)
N60 G1 X#100 Y#101
```

Definition commands in blocks N40 and N50 are executed after the movement of block N30.

☞ *Conclusions:*

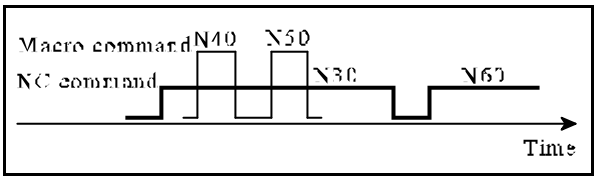
– program execution is slower,

– if execution of block N30 is interrupted and afterwards the machining is restarted the machining can be simply continued since variables of block N30 are not overwritten by block N40, N50.

SBSTM =1

```
%O1000
...
N10 #100=50
N20 #101=100
N30 G1 X#100 Y#101
N40 #100=60 (definition during N30)
N50 #101=120 (definition during N30)
N60 G1 X#100 Y#101
```

Definition commands in blocks N40 and N50 are executed during movement in block N30.



☞ *Conclusions:*

– program execution is faster,

– if execution of block N30 is interrupted and afterwards the machining is restarted the machining can not be continued, only if block search is started for block N30 since variables of block N30 are already overwritten by block N40, N50.

9162 **MD8** (BIT)
when executing subprograms and macros from 8000 to 8999 subprogram and macro blocks
0: are not listed and there is no stop after any subprogram or macro execution in single block mode,
1: are listed and there is a stop after every subprogram or macro execution in single block mode.

9163 **MD9** (BIT)
when executing subprograms and macros from 9000 to 9999 subprogram and macro blocks
0: are not listed and there is no stop after subprogram or macro execution in single block mode,
1: are listed and there is a stop after subprogram or macro execution in single block mode.

***9181 INTERRUPT** subgroup (BIT)*

9181 **MIUSED** (BIT)
0: macro interrupt is not used,
1: macro interrupt is used.

9182 **MSPINT** (BIT)
0: macro-type interrupt,
1: subprogram-type interrupt.

9183 **TYPINT** (BIT)
0: macro interrupt is also effective during block execution,
1: macro interrupt is only effective after block execution.

9184 **ELT** (BIT)
0: user macro interrupt is level-controlled,
1: user macro interrupt is edge-controlled.

9184 **MCON** (BIT)
0: the enabling and disabling of macro interrupt is executed by M96, M97,
1: the enabling and disabling of macro interrupt is executed by the M function specified at parameter **MMION**, **MMIOFF**.

***9201 MINTERR** subgroup (WORD)*

9201 **MINON** (WORD)
M code enabling interrupt macro call.

9202 **MINOFF** (WORD)
M code disabling interrupt macro call.

☞ *Note*: See also parameter **MCON**.

9221 INT_IO subgroup (BYTE)

9221 **I_LINE** (BYTE)

It shows the interface input line read by macro variables #1000...#1015, #1032.
The correlations:

1st board	inputs I000...I007, I010,...I017:	I_LINE=0
	inputs I020...I027, I030,...I037:	I_LINE=2
	inputs I040...I047, I050,...I057:	I_LINE=4
	.....	
2nd board	inputs I100...I107, I110,...I117:	I_LINE=10
	.....	

Odd number can also be written at the parameter: I_LINE=3. Its interpretation: I030,...I037, I040...I047.

9222 **O_LINE** (BYTE)

It shows the interface output line read or written by macro variables #1100...#1115, #1132.
The correlations:

1st board	outputs O000...O007, O010,...O017:	O_LINE=0
	outputs O020...O027, O030,...O037:	O_LINE=2
	.....	
2nd board	outputs O100...O107, O110,...O117:	O_LINE=10
	.....	

Odd number can also be written at the parameter: O_LINE=1. Its interpretation: O010,...O017, O020...O027.

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